EVALUATING INTRAOBSERVER ERROR IN LOCATING VARIOUS CEPHALOMETRIC LANDMARKS IN MANUAL METHOD-A RADIOGRAPHIC STUDY

[1]Priyanka Jaiswal, [2]Himanshu Kanungo, [3]Mukesh Gupta, [4]Kratika Mishra, [5]Anshul Bansal, [6]Priyanka Meena

[1]Post graduate student, Department of Orthodontics & Dentofacial Orthopaedics,Index Institute of Dental Sciences, Indore, MP.

[2]Professor & Head, Department of Orthodontics & Dentofacial Orthopaedics, Index Institute of Dental Sciences, Indore, MP

[3]Professor, Department of Orthodontics & Dentofacial Orthopaedics,Index Institute of Dental Sciences, Indore, MP

[4]Reader, Department of Orthodontics & Dentofacial Orthopaedics,Index Institute of Dental Sciences, Indore, MP

[5]Post graduate student, Department of Orthodontics & Dentofacial Orthopaedics,Index Institute of Dental Sciences, Indore, MP.

[6]Post graduate student, Department of Orthodontics & Dentofacial Orthopaedics, Index Institute of Dental Sciences, Indore, MP.

Corresponding author

Dr. Priyanka Jaiswal, Post graduate student, Department of Orthodontics & Dentofacial Orthopaedics,Index Institute of Dental Sciences, Indore, MP. Email id: Priyanka.jais006@gmail.com.

Abstract

Aim: study was aimed evaluate intraobserver error in locating various cephalometric landmarks in manual method.

Materials and Methods: A total of 30 pre-treatment lateral cephalogramswere taken which were selected randomly from the department records. The lateralcephalogramsrecords were traced mannualyfor various cephalometric landmarks at 7thdays and 14th days intervals to check for intra-observer error using a double determination test.

Results: Datawere described as mean and standard deviation. The intra-observer correlation was assessed using the intra-class correlation coefficient.P value<.05 was considered statistically significant.

Conclusion- There was no significant difference seen in values obtained from tracing done at 7th and 14th day. Both values showed correlation and there was no intra-observer error in manual tracing for locating cephalometric landmarks.

Keywords: Cephalogram, landmarks, teeth, malocclusion.

Introduction

A two-dimensional image of the skull taken from the side produces a cephalometric radiograph, which helps to show the relationship between the teeth, bone, soft tissue, and empty spaces in both horizontal and vertical planes of space.

Assessment of dental and skeletal malocclusion requires cephalometric evaluation, which is commonly used in the field of orthodontics. However, the procedure of cephalometric evaluation is time-consuming and it is prone to various errors. The types of errors include, errors related to technical measures, radiography acquisition, and identification landmarks.Appropriate cephalometric evaluation can give needed information which is helpful in determining orthodontic and maxillofacial surgery treatment options. However, the quality of evaluation and gained information depends on the correctness of landmarks identification on cephalograms, which could be vulnerable to inter- or intra-observer variations.[1]Most errors occur in landmark identification and are influenced by clinician experience, landmark definition, image density and sharpness.[2-4]The reduction of a three-dimensional structure to a two-dimensional image adds to the difficulty.[5]

Broadbent and Hofrath introduced radiographic cephalometry to orthodontics in 1931, usingit in a new era.[6]Cephalometric photographs have grown to be a crucial component of orthodontics.For proper diagnosis and treatment planning, it is crucial to correctly identify landmarks on cephalograms.[7]Lateral cephalograms are used to access craniofacial growth and development over time, providing valuable information on the treatment progression and the long-term outcomes of orthodontic treatment.[8] The precise identification of cephalometric landmarks on a lateral cephalogram is important to the success of the cephalometric analysis.[9] The quantitative evaluation of the angles and distances between cephalometric landmarks provides anatomical information and surrounding soft-tissue aberrations and helps in evaluating the craniofacial growth pattern. Image quality of radiograph is a primary consideration in locating cephalometric landmark and during the conversion of analog cephalometric radiographs to digital format, the quality of the original film is a major factor that affects landmark identification.[10]

The study of malocclusion has benefited from cephalometric analysis,which has evolved into a reliable diagnostic technique in orthodontic research and practice.Tracing radiographic markers onto an acetate sheet is how traditional cephalometric analysis is carried out.The manual method is the most traditional and popular.[11]

Materials and method

The study was conducted on pre-treatmentcephalograms selected from department of Orthodontics & Dentofacial Orthopaedics. Approval was taken from ethical committee of institute to

conduct the study. A total 30 pre-treatment cephalograms were randomly selected from department records.

Inclusion criteria

- Good quality cephalograms
- Cephalograms with proper superimposition of bilateral structures.

Exclusion criteria

- History of Facial/ Orthognathic surgery.
- Syndromic, cleft lip and/or cleft palate patients
- Cephalograms with artifact.
- Cephalograms with poor contrast
- Cephalograms with gross asymmetry and taken with improper patient position.

Armamentarium to be used in the study (fig.1):

- Acetate sheet
- 3H pencil
- Eraser
- Sharpener
- Measuring Scale
- Protractor
- Adhesive tape
- X-ray Viewer
- Ruler
- Tracing template

Fig. No. 1: Armamentarium used in the study

All cephalograms were traced mannualy to identify various cephalometric landmarks. Tracing was performed at interval of 7th and 14th day by same operator. For bilateral structures landmarks, average of two was taken and on each cephalogram,a total of 15 anatomical landmarks were identified.

Data was recorded in excel sheet and statistically analysed.

A portion of the randomly chosen lateral cephalograms will be retraced was employed in order to standardize the study and eliminate study errors.

Following points were used in the study (Fig.2):

- Sella: Midpoint of sellaturcica.
- Nasion: The most anterior point on the fronto nasal suture.
- Porion: The posterosuperior margin of internal auditory meatus.
- Orbitale: The anteroinferior margin of orbital cavity.
- Anterior nasal spine: The tip of the anterior nasal spine of the palate.
- Posterior nasal spine: The tip of the posterior nasal spine at the junction of hard and soft palate.
- Gonion: The angle of the mandible.
- Pogonion: The most anterior point of bony chin.
- Menton:The most inferior point of bony chin.
- Gnathion: The midpoint between pogonion and menton.
- • Condylion: The centre of the condyle head of the mandible.
- Basion:The most anterior point on the anterior margin of the foramen magnum where the midsagittal plane of the skull intersects the plane of the foramen magnum.
- Point G: Centre of the largest circle, i.e, at a tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis.
- Point M: Midpoint of premaxilla.
- Key ridge: Represents the zygomatic process of maxilla,they are lateral borders of the floor of the orbits.

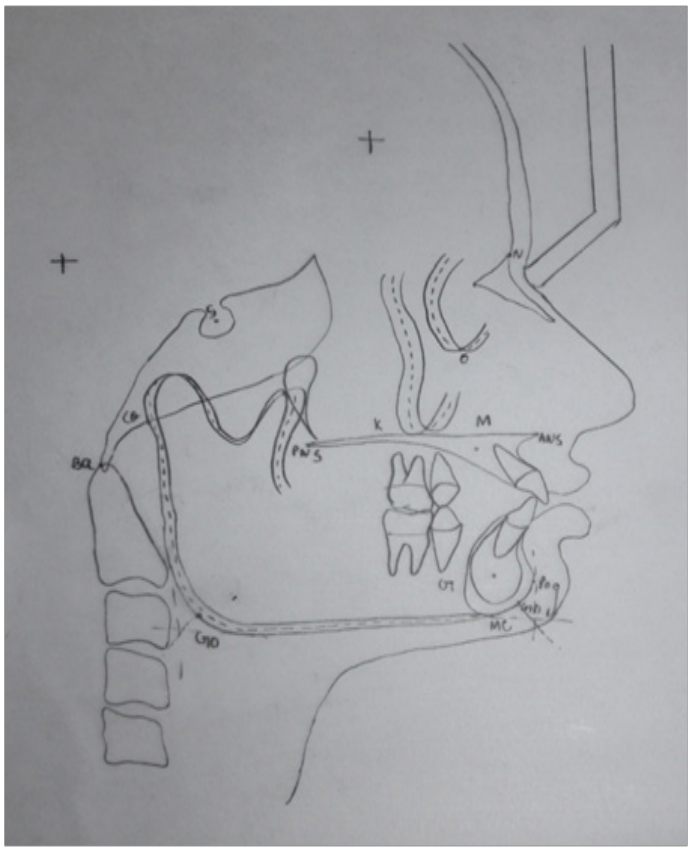

Fig. No.2: Cephalometric landmarks

Results

Data was analyzed in order to check for intra observer error using the double determination test.

Data were entered into the Excel sheet and analyzed using SPSS (Statistical Package for Social Sciences) 21.0 version, IBM, Chicago. Descriptive statistics were performed, and data were described as mean and standard deviation. The intra-observer correlation was assessed using the intraclass correlation coefficient. Pvalue<.05 was considered statistically significant.

Variable	Axis	Interval	Mean	Standard deviation	Intraclass correlation coefficient	p value
ANS	X-axis	7th day	51.8966	3.25516	.958	.001*
		14th day	51.4828	3.49102		
	Y-axis	7th day	18.4138	2.86004	.860	.001*
		14th day	17.7241	3.34767		
Basion	X-axis	7th day	50.4483	5. 49406	.950	.001*
		14th day	49.4138	5.82799		
	Y-axis	7th day	108.3103	5.37922	.976	.001*
		14th day	107.6897	5.85603		
Condylion	X-axis	7th day	42.4138	4.66382	.942	.001*
		14th day	41.1724	5.10650		
	Y-axis	7th day	93.4828	27.20376	.997	.001*
		14th day	92.4483	27.49622		
Gnathion	X-axis	7th day	106.7931	8.25218	.985	.001*
		14th day	106.2069	8.52467		
	Y-axis	7th day	28.6207	5.47340	.983	.001*
		14th day	28.6207	5.60875		
Gonion	X-axis	7th day	84.4483	11.98686	.998	.001*
		14th day	84.1034	12.21634		
	Y-axis	7th day	80.2414	29.35090	.998	.001*
		14th day	79.3793	29.77585		
Key ridges	X-axis	7th day	46.9655	5.33508	.997	.001*
		14th day	46.8621	5.37005		
	Y-axis	7th day	41.3103	9.30477	.993	.001*
		14th day	41.0000	9.13392		
Menton	X-axis	7th day	109.1379	6.62638	.946	.001*
		14th day	108.5517	7.44785		
	Y-axis	7th day	32.2414	6.89024	.928	.001*
		14th day	30.9655	7.00756		
Nasion	X-axis	7th day	13.2414	8.72867	1.000	.001*
		14th day	13.2414	8.72867		
	Y-axis	7th day	56.0345	43.60167	1.000	.001*
		14th day	55.9310	43.69614		
Orbitale	X-axis	7th day	27.7931	7.00193	.979	.001*
		14th day	27.2069	7.25248		
		7th day	37.2759	2.51987		Y-axis
		14th day	37.0690	2.63128		
PNS	X-axis	7th day	53.6552	10.03663	.990	.001*
		14th day	53.0345	10.05159		
	Y-axis	7th day	67.8966	4.65483	.922	.001*
		14th day	67.1034	5.55071		
Pogonion	X-axis	7th day	99.5172	4.91805	.951	.001*
		14th day	98.9310	4.93480		
	Y-axis	7th day	24.9310	4.76543	.963	.001*
		14th day	24.3448	5.00197		
Point G	X-axis	7th day	114.4483	85.20043	1.000	.001*
		14th day	113.7241	85.36681		
	Y-axis	7th day	31.3448	6.18336	.984	.001*
		14th day	31.0000	5.99404		

Point M	X-axis	7th day	54.9655	10.86437	.973	.001*
		14th day	53.8966	11.19421		
	Y-axis	7th day	27.6897	3.83688	.932	.001*
		14th day	27.2414	4.29830		
Porion	X-axis	7th day	31.1724	6.10076	1.000	.001*

Table 1: Description of median values of various parameters.

Discussion

In Orthodontic practice and research, cephalometric analysis is a trustworthy diagnostic method that has aided in the study of malocclusion. The conventional cephalometric analysis involves tracing radiographic landmarks on an acetate sheet.Theoldest and most often used approach is manual to assess the accuracy of landmark recognition using a manual process.

Cephalometric analysis is an essential tool of orthodontic diagnosis as well as treatment planning in Orthognathic surgery. The first step of cephalometric analysis requires identifying cephalometric landmarks, a labour-intensive and time-consuming task for even well-trained orthodontists. In addition, cephalometric analysis suffers from two types of errors—including projection error caused by projected X-ray images from 3D objects—and identification errors caused by incorrect identification of landmarks, tracing, and measurements.[12-14] Among these errors, the inconsistency in landmark identification may prove greater than other errors.[15] The variation of landmark definition, bony complexity of the related region, and the quality of the X-ray image could affect accuracy of landmark identification. Even after expert orthodontists received standardized training for landmark identification, disagreement between inter-observers was inevitable.[16]

In the present study, we evaluated the reliability of landmark identification in locating various cephalometric landmarks using a manual method. This identification guide was available in X and Y axes.The study's findingswere analyzed by using SPSS (Statistical Package for Social Sciences), 21.0 ve rsion, IBM, Chicago.

Data were summarized using descriptive statistics.The intraclass correlation coefficient was

used to evaluate intraobserver correlation.P values werelower than05. were regarded as statistically significant.There is no discernible variation in the intra-observer error

When comparing the 7th and 14th days of Sella's evaluation, perfect homogeneity wasattained. Additionally, on the Y axis, manual landmark plotting indicated good reliability and the values were statistically significant.

On the X axis and the 1st and 14th day of the Y axis, the ICC value of Nasion is 1.And there was almost complete agreement on the X and Y axes.Porion has an ICC score of 0.97 and occurs on days 7 and 14.And there was perfect agreement on the X and Y axes.ICC score is 0.978, according to orbitale in the X axis.And on the 7th and 14th days, it is 0.93 on the Y axis.

The intrarater agreement between the 7th and 14th days was essentially flawless.

The ICC

of ANS is 0.95 on the X axis and 0.86 on the 7th and 14th day on the Y axis.And there was

almost complete agreement on the X and Y axes.PNS has an ICC value of 0.99 on both the X and Y axes.

The 7th and 14th day's ICC values for Point G are 1.0 on the X axis and 0.98 on the Y axis.

Additionally, there was flawless agreement on the X and Y axes. The ICC of Point M is 0.97 on the X axis and 0.93 on the 7th and 14th day on the Y axis.And there was almost complete agreement on the X and Y axes.Pogonion's ICC value is 0.95 on the X axis and 0.96 on the Y

axis on the 7th and 14th day.And there was almost complete agreement on the X and Y axes.

Baumrind and Frantz[13] (1971) considered many different sources in error analysis, but by superimposition of all their readings, no distinction was made between the intra- and inter-observer tracing errors. The error for the different landmarks they measured is dependent on the error of sella and nasion, because the x-axis was defined as the best estimation for these two points.

Houston et al.[12] (1986) stated that the greatest contribution to the error variance is from the tracings. The between radiographs variance is generally small and inconsistent, but no significant information about differences was reported in their study. Battagel[17] (1993) suggested that the error of measurement is of importance and concluded that Dahlberg's estimation is mathematically the soundest method to evaluate measurement error.

In another study, all the contributing factors that make part of the whole measurement error were assessed to determine their individual contribution in the whole measurement error. The results showed that the errors involved in the digitizing procedure are minimal in comparison with those in the tracing procedure. The amount of error was different for each considered landmark: the smaller the error in the determination of the relevant landmarks, the smaller the error involved in the angles or distances of a system of analysis. Tracing accuracy was dependent on the considered landmark and was found to be the most important source of error.[18]

Conclusion

In Orthodontics, cephalometricsplay plays a major role in diagnosis and treatment planning. A cephalometric radiograph produces a two-dimensional image of the skull in lateral view, which helps to enable the relationship between teeth andsoft tissue, in horizontal and vertical planes. Present study evaluated the reliability of landmark identification and determined intraobserver errorinlocatingvariouscephalometric landmarks inmanual method.Thisidentification was evaluated in both the X and Y axes.An intra-observer correlation was assessed using the intraclass correlation coefficient.P value<.05 was considered statisticallysignificant.There was no significant difference seen invalues obtained from tracing done at 7th and 14th day. Both values showed correlation and there was no intra-observer error in manual tracing for locating cephalometric landmarks.

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