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LANDMARK IDENTIFICATION ERRORS IN CEPHALOMETRICS: A COMPARATIVE STUDY

Mariya Qadir[1] ,Mohammad Mushtaq[2]

1.Resident,Department of Orthodontics and Dentofacial Orthopaedics,Government Dental College and Hospital, Srinagar, J&K, India

2.Professor and Head , Department of Orthodontics and Dentofacial Orthopaedics,Government Dental College and Hospital, Srinagar, J&K, India.

ABSTRACT:

Introduction: Cephalometric analysis is an important task in orthodontic diagnosis and treatment planning.Hence errors associated with it should be identified and quantified.The present study is aimed at identifying errors associated with landmark identification.

Materials and methods: Cephalograms of 90 individuals were traced and after a gap of one week traced again by same operator to identify error in landmark identification.

Results: After statistical evaluation it was found that the difference between pre and post one week values was significant in identification of Porion, Orbitale, Condylion,Gnathion and insignificant in case of Sella, Nasion, Gonion.

Conclusion: Sella, Nasion , Gonion are reliable landmarks whereas Porion , Orbitale, Gnathion are unreliable and should be used carefully.

Key Words: Cephalometric errors, reliability, reproducibility, landmark identification, lateral cephalogram

INTRODUCTION:

Literally "cephalometrics" means measurement of head.Cephalometrics has been cornerstone of orthodontics since the time it was introduced by Broadbent [1] (USA) and Hofarth [2] (Germany).Basically it is a standardized technique of obtaining radiographs of skull which can be used for assessment of dental, skeletal, soft tissue and airway analysis.Uses of cephalometrics in orthodontics are varied ranging from diagnosis and treatment planning, during active treatment [1], end of treatment, during retention to assess relapse and unfavourable growth, assess and monitor growth by using series of radiograph or compare it to norms [3], for research purposes. Angular and linear measurements have been incorporated into various cephalometric analyses to help the clinician for diagnosing discrepancies in all three dimensions. All these applications rely on the fact that the process of taking and assessment of cephalogram should be free from errors or with minimum errors.

Cephalograms do have some inherent shortcomings like use of reference planes which always might not be reliable, difficulty in landmark identification, measurement error, comparison with those norms which are not applicable to every population group.

Errors with landmark identification have been identified in various studies [4,5,6]

*Corresponding Author Address: Dr. Mariya Qadir. E-mail: mariyaqadirpir@gmail.com

as well measurement errors have been identified in other studies [7].The influence of use of cephalometry and its influence on treatment planning has also been studied and varying views have been presented. In a study conducted by Brukes [8] (1999), White [9] (1992) to determine the reliability of cephalometrics in the treatment plan it was observed that only 4-20 % of treatment plan is influenced by cephalometrics.

In another study conducted by Nijkamp [10] (2008), it was observed that cephalometrics are not required for orthodontic treatment planning, as it did not influence treatment decisions for patient with class II malocclusion.

Ideally a cephalometric measurement should be reliable,not be influenced by change in position and growth, landmarks should be easy to identify.

Errors in cephalomatrics can be projection errors ,errors in landmark identification,errors in measurement system.All these errors thought totally cannot be eliminated but can be minimized by following standardized techniques right from taking the radiograph to assessment of cephalograms.

Even with these shortcomings cephalometrics continue to be a mainstay of diagnosis and treatment planning in orthodontics and hence this study was conducted to identify and quantify the error of land mark identification in a local study group.This will ultimately help us in identifying more reliable land marks.

MATERIALS AND METHODS:

The study was carried out on the patients received in the Out-Patient Department of the Department of Orthodontics & Dentofacial Orthopaedics, Government Dental College & Hospital, and Srinagar. The sample for this study consisted of 90 subjects which included 47 males and 43 females. Those subjects between the age group of 15-35 years,with normal acceptable profile, with Angle's Class I molar relation who did not undergo any prior orthodontic treatment and had a full complement of permanent teeth up to 2nd molars were selected for the study. It was ensured that the subjects selected had no caries or missing teeth, periodontal problem, TMJ abnormality any associated syndrome and had not undergone any surgery. Lateral standardized cephalograms were taken by a single operator using the same X-ray device and a standardized procedure,with cephalograms being taken in Natural Head Position based on the work of Solow and Tallgren [11] . The cephalograms were made with the mandible in the intercuspal position with an anode to midsubject distance of 5 feet.Thyroid shield and lead apron were worn by the subject to reduce radiation exposure.The procedure was approved by the ethical committee of the institution and a written consent was obtained from each participant. Lateral cephalogram was traced upon

an A4 size acetate paper with a 2B or 3HB hard lead pencil over well-illuminated viewing screen. The linear measurements were recorded with a measuring scale up to a precision of 0.5 mm. The angular measurements were analysed with a protractor up to a precision of 0.5°. The same cephalograms were traced by the same operator using same method after one week. This was done to remove the possibility of all other errors except the error of land mark identification, which was the main aim of the study.Errors in landmark identification were studied by observing those values which were influenced by these landmarks. The reference points and variables used are shown in Figure 1.

Sella (S):-The midpoint of the hypophyseal fossa.It is a constructed point in the median plane [12].

Nasion (N):- The anterior point of the fronto-nasal suture in the median plane [12].

Menton (Me) **:-**The lowest point on the symphyseal shadow of the mandible seen on the lateral cephalogram [13].

Gonion (Go): **-** A constructed point, the intersection of the lines tangent to the posterior margin of the ascending ramus and the mandibular base [14].

Articulare (Ar):- The intersection point of the inferior cranial base surface and the averaged posterior surfaces of the mandibular condyles [12].

ANS point (ANS):- The most anterior point of the bony hard palate in the mid-sagittal plane [12].

PNS point (PNS):- The most posterior point of the bony hard palate in the mid-sagittal plane [12].

Point A (Subspinale):- The most posterior midline point in the concavity between the anterior nasal spine and the prosthion [13].

Point B (Supramentale):- The most posterior midline point in the concavity of the mandible between the most superior point on the alveolar bone overlying the lower incisors and pogonion [13].

Pogonion (Pog): **-** The most anterior point on the chin [13.,15].

Gnathion: **-** A point located by taking the midpoint between the anterior (Pogonion) and inferior (Menton) points of the bony chin [13].

Porion(Po) **:–** the superior point of the external auditory meatus (the superior margin of the temperomandibular fossa, which lies at the same level, may be substituted in the construction of Frankfort horizontal) [13].

Orbitale(Or):- the lowest point in the inferior margin of the orbit, midpoint between right and left images [15].

Condylion (Co) **:–** the most superior point on the head of the condylar head [12].

Statistical analysis:The statistical analysis of data was carried with the help of means, ranges and standard deviations. Pre and post one week mean values were subtracted to obtain the net change achieved. Student's t-test was used to test the difference between means of various variables. In the statistical evaluation, the following levels of significance were used:

P > 0.05 Non-significant

0.05 ≥ P > 0.01* Significant

0.01 ≥ P > 0.001** Highly significant

P ≤ 0.001*** Very highly significant

RESULTS:

As shown in Table 1. the mean values of SNA and SNB showed insignificant difference when measured repeatedly showing that cephalometric landmarks S, N, A, B are reliable.Cranial base measurements except gonial angle showed no significant difference.Steiner's mandibular plane angle also showed significant difference.Hence it can be observed that Gnathion is not a reliable cephalometric land mark.Measurements involving Frankfurt Horizontal plane like N⊥ A, N⊥ Pog show significant differences showing that landmarks porion and orbitale are not reliable.Effective mandibular length also showed significant difference due to non reliability of Condylion and Gnathion.Value of upper incisor to palatal plane also does not show significant difference.

DISCUSSION:

A thorough background in craniofacial growth and development is necessary for every orthodontist. An important concept in the study of growth and development is variability.

The science of jaw proportions and measurements became much more relevant to orthodontics and this was made possible with the advent of cephalometrics [16]. Cephalometric radiography though introduced in orthodontics during the 1930's, only gained wider acceptance for practical application during the last half of the century. Over the years, a whole range of analyses have been developed by a number of authors. The aims of assessment tended to vary, ranging from studies on facial growth, the location of malformations, aetiological studies, establishment of norms etc. An analysis will provide the answers to a particular set of questions, and these answers will depend on correct application of the method and interpretation of results [12].

Simply calling a dimension 'large' or 'small' or 'good' or 'bad' does not mean same to everyone. In order to be descriptive and critical, it is more useful to express dimensions in terms of angles or linear measurements. Thus the purpose of analysis is to encompass the four "C's" of cephalometrics. These are to

1. Characterize or describe the condition that exists.

2. Compare one individual with another or the same individual with himself at a later time.
3. Classify certain descriptions into various categories.
4. Communicate all of these aspects to the clinician, to a fellow research worker or to the parent [25].

It is clear that cephalometric errors may arise due to errors in landmark identification.Hence due attention should be paid to precise definition of land marks ,calibrations of operators and repeated tracings [17]. Errors arising while obtaining radiographs can be minimized if careful positioning of patient is followed.This is in agreement with other studies [5,18,19].It is clear from this study that landmarks of Frankfurt Horizontal plane are not reliable. This is in agreement with other studies[20,21].Also Gnathion was not found to be reliable in this study,which was also observed in other studies [4,22,23,24].Cephalometric landmarks namely Sella, Nasion are quite

reliable. The points S and N are both located in hard, nonyielding tissue, are directly and easily visible in a lateral cephalogram, and particularly because they are located in the midsagittal plane and therefore are displaced to a minimum degree by movement of the head [14].

But position of Nasion can change according to some studies [26]. Points A and B have also been found to be reliable in the present study but both these points have been found to change with growth and orthodontic treatment [27].But in this study we have taken a sample which has not been treated orthodontically hence this variation in landmarks can be overruled .Condylion was found to be non reliable in the present study which is in agreement with other authors[28,29]. In the modern biological era, variation is the theme and the clinician's task is to achieve the desired facial and dental outcomes within the ability of individual to adapt physiologically to the morphologic changes.

Clinical implications:

This study has relevance in day to day practice as cephlometrics is a common diagnostic tool and recognition of errors in identification of some of the common cephalometric landmarks can help us in understanding our diagnosis and treatment planning in a much better way.

CONCLUSIONS:

Following conclusions can be drawn from the study:

1. Sella and Nasion are reliable landmarks with an insignificant difference between pre and post one week measurements.
2. Porion and Orbitale are not reliable landmarks interms of identification.
3. Conylion and Gnathion also show poor reproducibility.

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FIGURE:

Figure 1: Reference points and variables

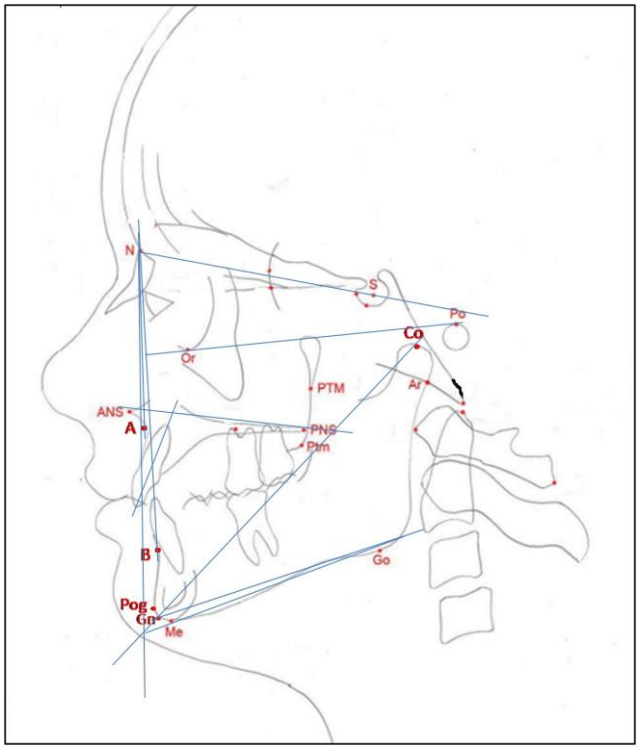

TABLE:

Table 1: Descriptive statistics showing pre and post one week comparison

S.NO	PARAMETER	PRE VALUE (mean)	POST VALUE (mean)	DIFFERENCE	P VALUE
1.	**SNA(^{0})**	81.65	82.00	0.35	-
2.	**SNB(^{0})**	79.22	79.02	0.2	-
3.	**N to Pt.A – FH Plane (mm)**	1.45	3.01	1.56	***
4.	**N to Pog – FH Plane (mm)**	-3.77	-5.79	2.02	***
5.	**Saddle angle (N-S-Ar) (^{0})**	126.04	126.06	.02	-
6.	**Articular angle (S-Art-Go) (^{0})**	144.24	143.92	.32	-
7.	**Gonial angle (Ar-Go-Gn) (^{0})**	127.74	125.22	2.52	***
8.	**Effective mandibular length(Co-Gn) (mm)**	102.6	104.96	2.36	***
9.	**Maxillary incisor position(UI-PP)(mm)**	76.22	76.01	0.21	-
10.	**Steiner's MPA(^{0})**	28.66	31.99	3.33	***
11.	**Down's MPA(^{0})**	25.93	25.95	0.02	-