Correspondence of Cephalometric Values. A Methodologic Study Using Duplicating Films of Lateral Head Plates

EINAR KVAM, D.D.S., LIC.ODONT.

OLAF KROGSTAD, D.D.S.

INTRODUCTION

Orthodontic diagnosis and treatment planning is strongly influenced by the complex pattern of the growing face.[19,28] In addition, many problems are encountered in obtaining reliable data of individual facial and dental relationship.[1,7,17,25] Different cephalometric systems and definitions have been introduced to obtain cephalometric data.[23] Thus a variety of different measurements are regularly used at various orthodontic departments.[9,16]

It is reasonable to assume the measurements on identical x-ray head plates will vary when orthodontists regularly using different systems are practicing a cephalometric procedure.

For comparative purposes it is of importance to know the range of the methodologic variability.[3,4,5,10,12,14,15] Such information may also contribute to obtaining standardized definitions of landmarks and reference lines.[16]

The aim of the present investigation was to study this variability. Identical duplicating films of cephalograms were traced and measured at twenty-three different orthodontic departments in Europe. Since the measurements depend upon the definition of the landmarks used, and on the quality of the x-ray copies, these factors were also considered.

MATERIALS AND METHODS

Material: Five lateral x-ray films were exposed in a modified Evald-Harvold cephalostat, which had a focus-MSP (midsagittal plane) distance of 156 cm and a film-MSP distance of 23 cm. The films (Du Pont Cronex 4) were developed and fixed (Agfa Gewaert G 134) at 25°C in a machine. The duplicating films (Kodak D.G. 54) were exposed by a light source of 116 cm for 35-50 seconds while in close contact with the master film. The duplicating films were developed and fixed in accordance with the manufacturers' instructions. Care was taken to standardize the exposure, the development and the fixing of the films.

Methods: To an invitation to take part in the study as outlined above, twenty-nine out of thirty European orthodontic departments responded. Twenty-seven were willing to take part in the investigation. The participants were asked to trace eight different angles,[18] namely s-n-ss (SNA), s-n-sm (SNB), FH-ML,* NL-ML, $\underline{1}$-FH, $\underline{1}$-NL, $\overline{1}$-ML and $\underline{1}$-$\overline{1}$. Tracing values of the twenty-seven respondents were received from twenty-three different departments representing eight different countries.

Conventional definitions of the landmarks applied were enclosed.[18] Each participant was asked to note whether

From the Dental Institute of Experimental Research and the Department of Orthodontics, Dental Faculty, University of Oslo, Norway.

* ML = tangential line of lower posterior border of mandible to gnathion. NL = line connecting anterior nasal spine and pterygomaxillare.

other definitions than those enclosed had been used for the tracing procedure. In addition, the participants were requested to give their opinions on the quality of the copies.

Findings

The majority of the duplicating films was considered to be of average (45) or good quality (26), although a fairly large proportion was characterized as bad (46). A certain difference existed between the films so that films numbers 1 and 4 were considered better than the remaining ones.

The participants were also asked to note whether definitions other than those enclosed were used. For the angles s-n-ss, s-n-sm, $\underline{1}$-ML and $\underline{1}$-$\overline{1}$, only a limited number of the measurements had to be excluded due to differences in definitions of landmarks. Observations involving NL were based on so many definitions that those measurements had to be excluded. Due to similar reasons, also FH-ML was excluded. The present investigation is therefore dealing with the remaining five angles.

Three of the five angles evaluated had generally a rather low SD, namely s-n-ss, s-n-sm, and $\underline{1}$-$\overline{1}$. The corresponding values of $\underline{1}$-FH and $\overline{1}$-ML varied considerably, however. Thus, differences of 88° for $\underline{1}$-ML were observed. Since the main object of the study was to find whether reproducible values could be obtained, the distribution of the observations around the mean values of each angular measurement was of particular interest. From this point of view a restricted number of extreme findings is of less importance. This distribution is illustrated in Figures 1-4 where each observation is plotted in relation to the arithmetic mean (0) of the corresponding case. A certain difference appears between the various angles. This is clearly seen in Table 1 in which per cent observations as a function of 0.5, 1.5 and 2° difference from the arithmetic mean are grouped. As regards the measurements of $\underline{1}$-FH, these observations were so varying that they could not be drawn at a similar and reasonable scale.

Discussion

The cephalostat used in the study was a modified type with an increased MSP/film distance giving image characteristics which may have complicated the localization of the landmarks. In addition, it may be questioned whether duplicating films are representative for original head plates usually available for diagnostic purposes. Films 1 and 4 received somewhat better estimation than the other ones, but the standard deviation of these measurements did not appear to be markedly different as compared with the other films. Duplicate film 3, which was regarded inferior to 1 and 4, had the smallest variability of all the cases. The values obtained did not differ markedly as compared with those obtained in other studies in which original films were traced by more than one operator.[9,10,18] Even if the duplicate films will be different from original head plates, the present findings indicate that the material available can be compared with values obtained when regular films are used.[18] This is of importance for comparative investigations of this nature as experience in tracing is often pointed out as essential for such work.[18,25,26] It must be emphasized that all duplicate films representing the individual cases were identical, a factor of importance for comparison of the findings.

A difference appeared between the various measurements dealt with, however (Figs. 1-4). Angles s-n-ss and s-n-sm were determined with an acceptable accuracy, and the findings of $\underline{1}$-$\overline{1}$ can certainly be accepted when compared with similar investigations.[9,18] This was not the case with other measurements. The angle of $\overline{1}$-ML and the

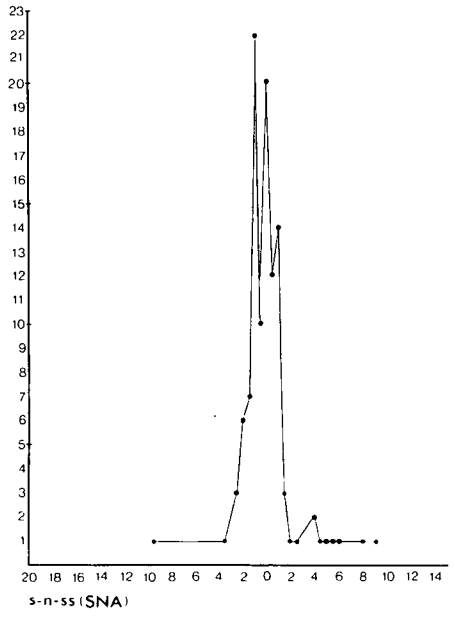

Fig. 1

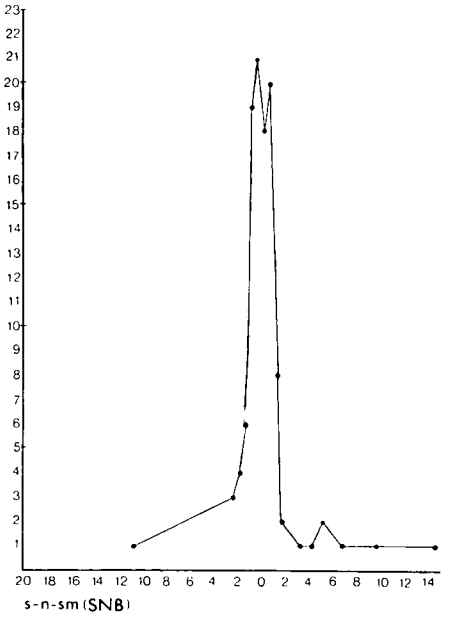

Fig. 2

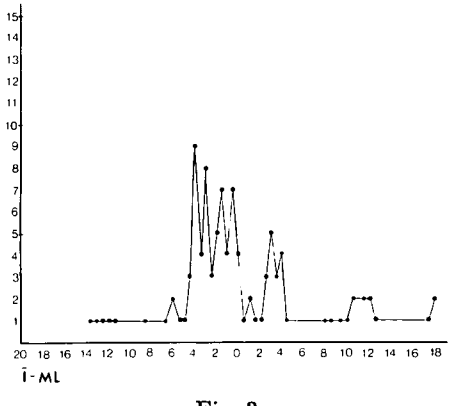

Fig. 3

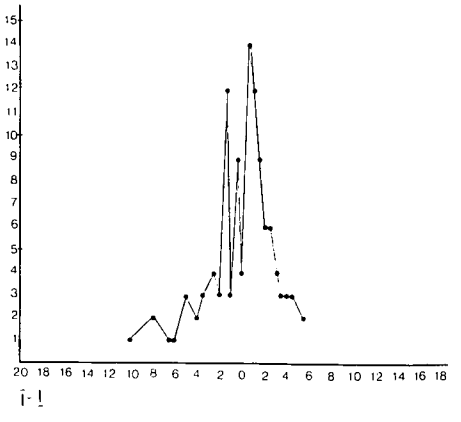

Fig. 4

TABLE 1

	n	$\bar{x}$	$\bar{x} \pm 0.5$	$\bar{x} \pm 1°$	$\bar{x} \pm 1.5°$	$\bar{x} - 2.0°$
S-N-SS (SNA)	109	18.35	40.47	71.56	80.73	88.99
S-N-SM (SNB)	109	16.51	54.13	78.90	86.24	89.91
$\bar{1}$-ML	100	4.0	12.00	18.00	26.00	32.00
$\underline{1}$-$\bar{1}$	110	3.64	24.55	38.18	57.27	65.45

n = number of measurements on five different copies.
$\bar{x}$ = arithmetic mean

Table 1. Percentage distribution of all values (n) around the arithmetic mean ($\bar{x}$) and $\bar{x} \pm 0.5$, 1, 1.5 and 2°.

angle of $\underline{1}$-FH had ranges of 88° and 30.5°, respectively, excluding any practical application. The size of error is so great when compared with the angles s-n-ss, s-n-sm and $\underline{1}$-$\bar{1}$ that it is apparent that factors other than the measuring errors must have been involved. It is tempting to ascribe some of the differences to the interpretation of the reference system, particularly to the presence of bilateral images. The distribution of measurements as shown in Figure 3 indicates that some have been using images restricted to only one of the bilateral structures.

The correspondence of values of the other angles were somewhat unexpected, however. Thus, measurements including localization of point ss, which has no definite anatomical definition,[8,13] rendered acceptable values.

Richardson[24] has pointed out that this point can be located with greater accuracy in the anteroposterior plane rendering comparable values for the s-n-ss angle. Other points have been proposed in order to obtain more reliable results[12,19] but this alteration does not seem to be indicated by the present findings.

The reference line FH is evidently not regularly used by the participants. This must in part be due to difficulties in the localization of the points upon which the plane is based[14,21] and to the biologic variability of the FH plane.[6] Salzmann,[26] however, regarded FH useful as a cranial base plane due to its close relation to the cranial base, and others[29] have pointed out the FH is biologically stable as a reference line. The measurements of the present study involving FH cannot be compared with each other indicating that the use of this reference plane must find preference on grounds other than reproducibility.

The distribution of all the findings when calculating the difference from the arithmetic mean was of interest because this will show the scatter of the observations. The figures will also reveal whether the findings of any of the participants were systematically located below or above the average values. This appeared to be true to a certain extent as regards $\underline{1}$-FH.

Participants obtaining high values in some cases had lower values in other cases. The great variability therefore seems to be due to methodological problems for some particular angles.

The findings of the angles s-n-ss and s-n-sm were acceptable, as well as the measurements of $\underline{1}$-$\bar{1}$. The latter observations may in part be explained by the fact that duplicating films will be richer in contrast of mineralized tissue components than the original head plates.

At present, longitudinal estimation of a patient appears to be of particular interest,[11] as prediction of growth and development seems highly unreliable.[2,12,20,22,27] However, for certain

anomalies of basal character, comparison with normative values must be of interest.

Summary

Duplicate films of five lateral head plates were traced and measured at the orthodontic departments of twenty-three European universities. The quality of the films was estimated, the reference points and lines defined, and the angles s-n-ss (SNA), s-n-sm (SNB), $\underline{1}$-FH, $\overline{1}$-ML and $\underline{1}$-$\overline{1}$ measured. The arithmetic mean and the standard deviation were calculated as well as the distribution of each angular measurement around the mean values.

The angles s-n-ss and s-n-sm disclosed a high degree of accuracy as 88.99% and 89.91% of the measurements were found at $\bar{x} \pm 2°$. $\underline{1}$-$\overline{1}$ had 65.45% of the observations within this range, whereas $\overline{1}$-ML had only 32% of the observations at $\bar{x} \pm 2°$.

Dental Institute of Experimental Research, University of Oslo, Blindern, Oslo 3, Norway

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