THE POSSIBILITY OF INTRODUCING ROENTGENOGRAPHIC CEPHALOMETRICS INTO PRIMATOLOGY

—— Preliminary Report ——

BY

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ABSTRACT

To examine the possibility of introducing roentgenographic cephalometrics into the field of primatology, eighteen roentgenograms of dry skulls of female adult irus monkeys from Malaya were investigated.

The landmarks used in the present study were selected mainly from those which had been used for the measurement of dry skull in primatology and some points were added from those which had been used in the field of orthodontics to analyse the pattern of human dentofacial complex. Using these landmarks, measurements were attempted on eight lines, ten angles and an area.

The ranges of the variation in every items of this study were not quite small, but that seemed to be due to the lack of enough size of sample and the presence of wide range of size within a single group. Except several items, the values of relative error of the other items distributed in a range from 1.89 to 6.78. These values were not entirely large. From the concept of confidential intervals, the enough size of sample to keep the relative errors under 3% was calculated as 77.

So it was suggested that roentgenographic cephalometrics is also valuable and useful in this field, if the enough numbers of materials are obtained.

INTRODUCTION

Since its introduction into orthodontics by Broadbent[2] and Hofrath[8] in 1931, roentgenographic cephalometrics[19,21] has been one of the greatest contributions to the progress in this field. It has been aplied not only to case analysis for orthodontic treatment (Downs[5], Graber[6], Higley[7], Iizuka and Ishikawa[10], Margolis[16], Tweed[22], Wylie[24], and others), but also to the study of development and growth of the dentofacial complex (Brodie[3], Coben[4], Iizuka[9], Inoue[13], Kobayashi and Inoue[14], Kuwahara[15], Sakamoto[18], and others) and to the comparison of facial patterns among the

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races (Altemus[1], Miura[17], and others). In the field of comparative anatomy, however, these kinds of studies on cranio-facial complex seemed to have been carried out by using direct methods such as biometrics or the measurement of dry skulls. Therefore, it should be of great value to introduce roentgenographic cephalometrics into primatology, for this would make it possible to carry out the measurement of the living body on its bony structures covered with soft tissues. At the same time, it is also valuable for orthodontics, which deals with the morphology of the human dento-facial complex as a basis for practice, as a possible way of explaining the pattern of the human cranio-facial complex from the standpoint of phylogeny.

In the present study, the possibility of introducing roentgenographic cephalometrics into primatology was examined by carrying out preliminary measurement. From the result of this study, it was also attempted to make an orientation for studies in future.

Materials

The roentgenographic cephalograms of dry skulls of one hundred monkeys, owned by the Japan Monkey Center, were taken (Fig. 1). From these materials, eighteen films of female adult[20,23] irus monkeys from Malaya were selected for the preliminary examination, because the group were the largest in the size of samples.

The data of x-ray exposure was as follows:

X-ray unit: Model HV 150 of Osaka Roentgen K.K.

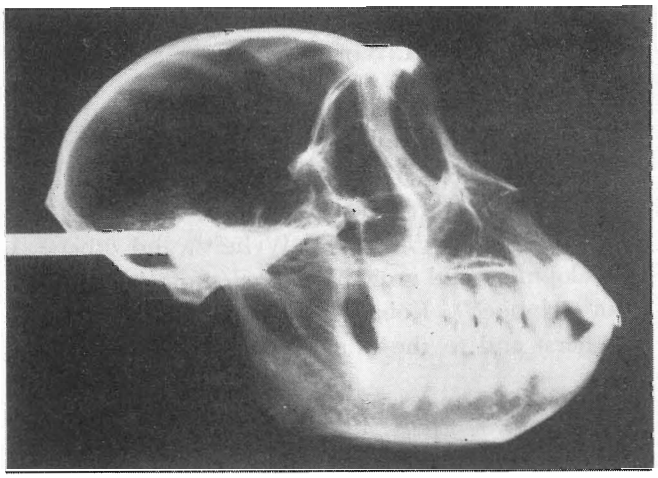

Fig. 1. Roentgenographic cephalogram of female adult irus monkey from Malaya.

Exposure data: 45–55 kV., 30 mA., 0.05 μF.
Filter: 0.5 mm Aluminium.
Film: Fuji X-ray film PX.
Screen: Kyokko MS.
Geometrical condition:
Focus-Cranium (center) distance: 150 cm.
Cranium-Film distance: 15 cm.

Measuring Method

These eighteen cephalograms were traced with an established rule[12], and landmarks were plotted on this tracing paper. These landmarks were selected mainly from those which had been used for the measurement of dry skulls[23] (1–8). In addition, were added some points (9–12) which had been used for orthodontic diagnosis and dealing chiefly with dentofacial complex[11] (Fig. 2).

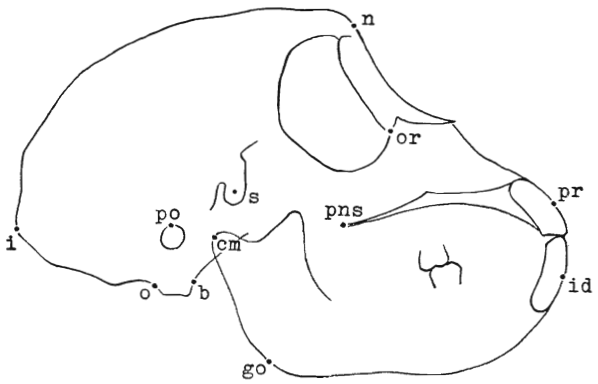

Fig. 2. Landmarks to be referred to in this study.

1	nasion	(n)
2	inion	(i)
3	prosthion	(pr)
4	basion	(ba)
5	gonion	(go)
6	infradentale	(id)
7	opisthion	(o)
8	capitullum mandibulae	(c.m.)
9	sella	(s)
10	porion	(po)
11	orbitale	(or)
12	posterior nasal spine	(pns)

Bregma (b), lambda (l), hormion (ho) and opisthocranion (op) could not be traced.

Using these points, measurements were carried out on the following items:

1) Linear measurement (Fig. 3)

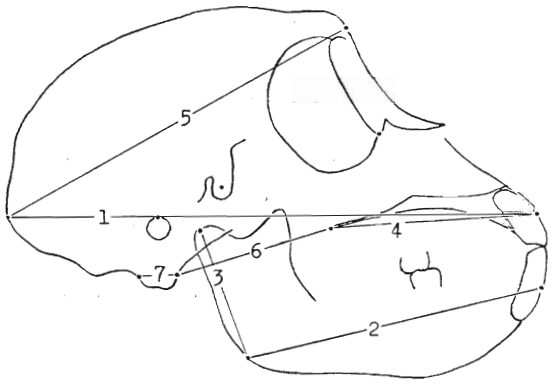

Fig. 3. Lines used for linear measurement.

1	pr-i	2	go-id	3	go-c.m.
4	pns-pr	5	n-i	6	ba-pns
7	ba-o				

2) Angular measurement (Fig. 4)

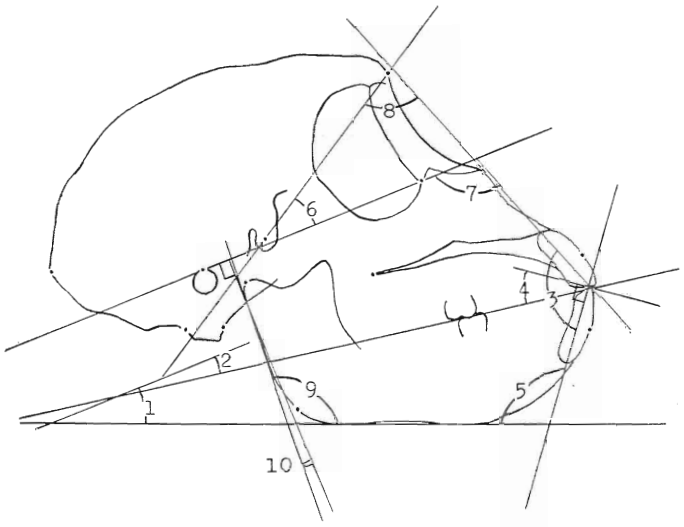

Fig. 4. Items for anglar measurement.

1 mandibular plane angle
2 occlusal plane angle
3 interincisor angle
4 L-1 to occlusal plane
5 L-1 to mandibular plane
6 FH to SN
7 U-1 to FH
8 U-1 to SN
9 gonial angle
10 ramus inclination

Results

The means, minimum and maximum values, standard deviations and variation coefficients of each item obtained from these measurements are shown in Table 1.

Table 1. Result of Measurement.

	Mean	Min.	Max.	S.D.	Var. Coeff.
pr-i	107.4 mm	97.3 mm	120.6 mm	5.3 mm	4.9%
go-id	63.7	55.6	74.0	5.2	8.2
go-cm	31.4	27.5	39.7	3.4	10.8
pns-pr	42.5	37.2	50.5	3.7	8.7
n-i	78.9	69.6	83.7	3.6	4.6
ba-pns	31.9	28.0	36.3	2.2	6.8
ba-o	8.5	7.5	9.7	0.6	7.1
mandibular plane	13.0°	6.0°	21.0°	4.8°	37.1%
occlusal plane	6.9	1.7	11.3	2.7	39.7
interincisor	104.3	84.3	121.5	7.8	7.5
L-1 to occl.	40.0	31.2	51.2	5.3	13.3
L-1 to mand.	123.0	110.0	131.0	6.0	4.8
FH-SN	31.3	26.7	37.5	2.4	7.5
U-1 to FN	119.0	105.3	125.2	5.3	4.4
U-1 to SN	88.2	78.5	97.7	5.6	6.4
gonial angle	105.3	96.0	111.2	3.9	3.7
ramus inclination	2.1	−3.6	8.7	3.1	147.1

Discussion

1. Landmarks and items for measurement

In general, landmarks for roentgenographic cephalometrics should be

such as those which 1) are indispensable and useful for evaluating morphological characters, 2) can be established exactly on the x-ray film corresponding to the actual points on the skulls and 3) have not too great a deviation between individuals. However, the landmarks and items for measurement used in the present study were not entirely satisfactory, because they were selected without any limiting considerations. It should be one of the first considerations to select the suitable measuring points with due regard to the above-mentioned criteria. This is essential for the comparison of facial patterns between races and for tracing the growth and development of individuals or races. At the same time, the angles and distances should also be selected concerning their ability to reveal morphological character, easiness and validity in measurement and stability in measured values.

On the other hand, it should be also a problem that some landmarks such as gnathion, pogonion and menton on the part of chin, and anterior nasal spine in the middle face do not exist in monkey skulls, though they had been used for human cranium. Instead of these points, new appropriate ones should be established for evaluating the depth and height of the monkey face, especially for the middle and lower anterior parts.

In addition, concerning the easiness in tracing the landmarks and its exactness, the method of x-ray exposure should be also improved.

2. Range of variance

As shown in Table 1, the ranges of variance were not so small in every item of this study. The maximum value of standard deviation in linear measurements was 5.3 mm of pr-i, and the minimum 0.64 mm of ba-o. Their coefficients of variation were 0.049 and 0.071 respectively. As one of the causative factors of these wide variance, the lack of enough size of samples might be pointed out. Another factor might be a wide range of sizes within a single group of adults.

The values of standard deviation in angular measurement were also considerably large. However, these values do not show evident dominancy, but correspond with those from, for example, Iizuka-Ishikawa's report[10] which dealt with 50 Japanese male adults (Table 2).

For the further discussion, the confidential intervals of mean in each item were estimated in the level of significance 95% as shown in Table 3, and the relative errors were also evaluated. Though, except mandibular plane angle, occlusal plane angle and raums inclination, these values of relative errors were not entirely large, they should be more shorter if possible. The enough sizes of sample to keep the relative errors of go-c.m. and L-1 to occlusal plane under 3%, were calculated from the concept of confidential intervals and resolved as 53 and 77 respectively. But, on the other

Table 2. Comparison of the size of standard variation with Iizuka-Ishikawa's.

	Present study		Iizuka-Ishikawa	
	Mean	S.D.	Mean	S.D.
mandibular plane	13.0°	4.8°	26.25°	6.34°
occlusal plane	6.9	2.7	9.52	4.01
interincisor	104.3	7.8	129.66	8.99
L-1 to occl.	40.0	5.3	21.69	6.03
L-1 to mand.	123.0	6.0	94.67	7.21
FH-SN	31.3	2.4	5.98	3.35
U-1 to FH	119.0	5.3	108.94	5.62
U-1 to SN	88.2	5.6	103.06	5.53
gonial angle	105.3	3.9	119.38	5.83
ramus inclination	2.1	3.1	2.64	4.14
numbers of materials	18		50	

Table 3. Confidential intervals of mean and relative errors of each item.

	Confidential interval of mean	Relative error
pr-i	107.4±2.71 mm	2.52%
go-id	63.7±2.68	4.21
go-cm	31.4±1.74	5.54
pns-pr	42.5±1.89	4.45
n-i	78.9±1.84	2.33
ba-pns	31.9±1.12	3.51
ba-o	8.5±0.36	4.24
mandibular plane	13.0±2.45°	18.85
occlusal plane	6.9±1.38	20.00
interincisor	104.3±3.98	3.81
L-1 to occl.	40.0±2.71	6.78
L-1 to mand.	123.0±3.06	2.49
FH-SN	31.3±1.25	3.99
U-1 to FH	119.0±2.71	2.28
U-1 to SN	88.2±2.86	3.24
gonial angle	105.3±1.99	1.89
ramus inclination	2.1±1.58	75.33

hand, to keep the errors of mandibular plane angle and occlusal plane angle under same degree of 3%, 560 to 640 samples should be required. These sizes of samples seemed to be available in the further studies in the exception of two items of the latters.

The expected possibility of roentgenographic cephalometrics in primatology will also be supported by the fact that these methods have been utilized for long time in the field of orthodontics in spite of such a large deviation.

3) Planning for further study

As described above, to make roentgenographic cephalometrics more useful in this field, further examination in the selection of landmarks and the establishment of measuring items should be required. When more reasonable plannings are achieved with regard to these factors, this method will bring the better understanding of the differences of morphological characters among each kind of monkeys and easiness in tracing the growth and development of individuals. From these standpoints, it may be said that roentgenographic cephalometrics has the possibility of a great future, also in the field of primatology. Hence, for the further studies, the following plans should be presented as: 1) Examination of the landmarks and measuring items, 2) Establishment of better exposure condition, 3) Relative morphological studies on the primates, 4) Studies of growth and development.

Summary and Conclusion

For the purpose of examination of the possibility in the field of primatology, roentgenographic cephalometric measurements on seventeen angles and distances were attempted on eighteen female adult irus monkeys from Malaya. From the result of this study, it was suggested that roentgenographic cephalometrics is also valuable and useful in this field.

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