Sex determination of the juvenile skull using cephalometric radiography in Japanese children

Hajime UTSUNO, Toru KAGEYAMA[1], Keiichi UCHIDA[2],
Yasunobu UMEMURA and Katsuhiro INOUE

Department of Oral Anatomy I , Matsumoto Dental University School of Dentistry
[1]Institute of Oral Science, Matsumoto Dental University
[2]Department of Oral Radiology, Matsumoto Dental University School of Dentistry

Summary

Facial reconstruction is a technique that allows human skeletal remains to be used to build a facial image of the target individual during life. This technique is based on databases of facial soft tissue thickness. However, application of this technique is facilitated by accurate information such as age, sex and ancestry. Little information is available from the skull alone for building face reconstructions, particularly for skulls from juveniles. This study estimated sex differences from the cranial bases of juvenile skulls and observed significant differences between male and female in the S–N plane for Japanese children at 6– to 18–years–old.

Introduction

Facial reconstruction is a technique of forensic anthropology that investigates facial likenesses and allows a face to be made using an unknown human skull. The technique is based on databases of facial soft tissue thickness[1-5]. When unknown human skeletal remains are found, forensic anthropologists estimate age, sex, ancestry and facial appearance based on skeletal evidence. Next, a forensic artist builds the face using a database of soft tissue thicknesses according to the anthropological data available[1-5].

In adults, determination of sex from the skull has been reported by several resesarchers[6-12]. However, sex determination from a juvenile skull has not been reported because characteristic features are generally considered to be absent[13-14]. The aim of this study was to differentiate morphological sex differences from unknown juvenile human skeletal remains, in order to assist forensic anthropologists and artists.

In this study, length of the front cranial base was measured using the distance between 2 anthropometric landmarks, the nasion (N) and the sella turcica (S)[15,16]. The line between these points is generally called the S–N plane and is used in diagnosis of orthodontic conditions and as a reference

plane to evaluate growth[17-23]. Sex differences in this plane have been reported for populations in England (for orthodontic treatment)[24], but Japanese populations have not previously been described. The present study examined sex differences in the front cranial base from pre-pubertal to sub-adult individuals.
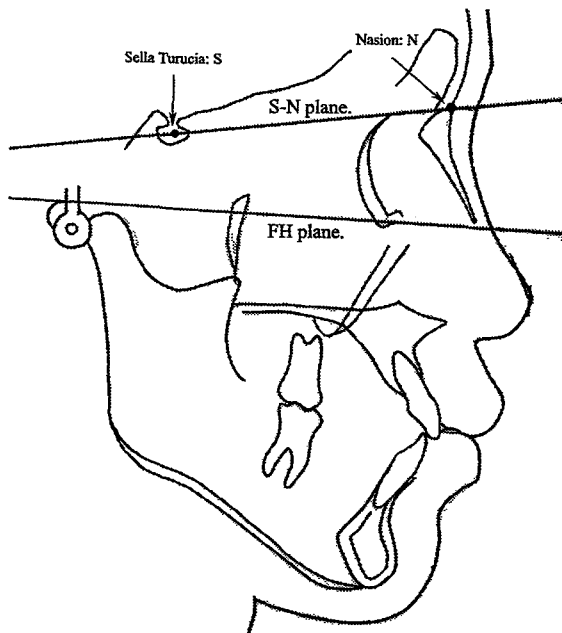
Materials and Methods

Fig.1 : Anthropometric Landmarks and S–N plane on cephalography and Sella turcica (S) and Nasion (N).

Measurements were taken using diagnostic cephalometric radiography (lateral view) from 128 boys (mean age, 12.4 years ; range, 7–18 years) and 112 girls (mean age, 12.2 years ; range, 6–18 years) who were undergoing diagnosis of malocclusion in the Department of Oral Radiology at Matsumoto Dental University. All subjects were otherwise in good health and were Japanese. Informed consent was obtained from parents . Cepahlometric radiography was performed using a film–to–tube distance of 165 cm and rigid head fixation. Skeletal features were traced on acetate sheets using craniographic methods[15-23]. Next, the following 2 anthropological landmarks on the sagittal plane were plotted for estimations : S, at the center of the hypophysial fossa ; and N, the intersection of the sutures of the left and right nasal bone and the frontal bone (Fig.1). Distance be-

Table 1 : Comparison of S–N distance between boys and girls each age group and Age (years).

Age	Male				Sig	Female			
Years	n	Mean	±SD	Range		n	Mean	±SD	Range
<9	18	61.6	2.14	65.2–58.8	**	35	65.8	2.71	74.2–61
10~11	34	62.7	2.49	68.6–57.7	**	49	66.5	2.48	70.5–60.1
12~13	31	64.9	3.07	70.6–60.1	N.S	22	66.0	2.68	71.6–61.2
14~15	28	66.2	2.67	72.7–61.8	N.S	17	65.6	4.52	73.8–59.6
16~18	17	67.4	3	71.8–63.6	*	37	65.0	3.13	73.5–60

** : P<0.01, * : P<0.05　　(mm)

Table 2 : Comparison of S–N distance mean (mm) between Japanese and British Caucasian.

Age	male		female	
Years	this study	Bhatia, (1993)	this study	Bhatia, (1993)
<9	61.6	65.1	65.8	62.8
10~11	62.7	65.8	66.5	63.5
12~13	64.9	67	66.0	64.9
14~15	66.2	68.6	65.6	66.1
16~18	67.4	70.3	65.0	66.4

tween point S and N was determined. After the measurements were classified for age groups of <9, 10–11, 12–13, 14–15 and 16–18 years, they were corrected to true size, as enlargement by a factor of 1.1 occurred in obtaining original measurements, to calculate mean and standard deviation. Statistical analysis of differences between sexes was performed using Student's t–test (Table 1). Finally, S–N distance was compared with other population data[24] (Table 2). Values of $P<0.05$ were considered statistically significant.

Results

Significant sex differences were observed between the <9 and 10–11 year age groups ($P<0.01$), and for the 16–18 year age group ($P<0.05$). In each age group, mean S–N length was larger for females than for males until 12–13 year age group. Mean S–N length was significantly smaller for Japanese males than for British Caucasian males. Conversely, mean S–N length tended to be slightly larger in Japanese females than in British females.

Discussion

The aim of this study was to ascertain a method by which sex could be estimated, to allow sex determination and subsequent forensic facial reconstruction for unknown juvenile human skull. Sex differences were identified for skull cephalometric parameters. Until 11–years–old, girls consistently demonstrated larger measurements than boys, with significant differences in S–N length ($P< 0.01$ for <9 years and 10–11 years). In addition, although no significant difference was observed, S–N length tended to be slightly larger in girls than in boys at 12–13 years. After 14 years, S–N length tended to be larger in boys than in girls, with a significant sex difference noted at 16–18 years ($P< 0.05$).

Table 2 shows that S–N length is larger in British Caucasian boys than in girls at all age groups. However, unlike British Caucasians, S–N length was larger in Japanese girls than in boys until 13–years–old, then was larger in Japanese boys compared to girls.

Sex differences between Japanese boys and girls appear attributable to a lag in growth for boys compared to girls. From pre–puberty to puberty, S–N length is larger in Japanese girls than in boys. Girls finish growing in puberty earlier than boys, resulting in a lack of sex differences at 12–15 years. After puberty, S–N length is larger in boys than in girls. Differences in growth patterns between Japanese and British Caucasian children could be attributable to morphological differences in skull shape among these groups. Skull length is similar between Mongoloids and Caucasians, but skull width is larger for Mongoloids than Caucasians. These differences could be reflected in the present findings.

In future research, the author intends to use current techniques to examine sex differences among the adult Japanese population and compare results with those found in other populations.

Conclusion

The present study reports aspects of sex determination for unknown juvenile human skulls. S–N length (cranial base length) is useful for unknown juvenile Mongoloid skulls at under 11–years–old or over 16–year–sold. On the investigation scene, S–N length can be obtained directly from the skull

without cephalometric radiography if the brain has been extracted. When precise age investigation has been performed, the methods described in the present study could help to clarify sex for the above ages.

Acknowledgements

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抄録：セファロ X 線規格写真を用いた日本人小児頭蓋骨の性別判定

宇都野　創，梅村恭伸，井上勝博（松本歯大・口腔解剖第一）

影山　徹（松本歯大・総歯研）

内田啓一（松本歯大・歯科放射線）

　法人類学においておこなわれる復顔法は身元不明頭蓋骨の生前の顔貌を推定する技術である．身元不明の頭蓋骨が発見された際，法人類学者によって年齢，性別，人種が鑑別された後にそれぞれの人種の顔面の軟組織厚のデータベースをもとに顔貌が作製される．成人の頭蓋骨において性別の鑑定法は数多く報告されており，その性差は比較的顕著である．しかし，小児の頭蓋骨においては思春期以前のものでは形態学的な差異は少ない．そこで本研究においては矯正治療の際に成長の指標となる基準平面である S-N 平面に着目し，その距離を計測した．S-N 平面は人類学的計測点である前頭骨と鼻骨の縫合部である N 点とトルコ鞍の中心点である S 点を結んだものである．本研究において著者らはセファロ X-線規格写真でこの距離を計測し，これを 9 歳以下，10～11，12～13，14～15，16～18歳の年齢別に分類し，各年齢別の性差を統計学的に処理して観察した．そしてこれらのデータは英国白人小児のものと比較検討をおこなった．

　年齢ごとの分類において 9 ～11歳の範囲で（P＜0.01）の性差が観察され，この年代においては男児より女児の計測値が大きかった．12～15歳の範囲においては有意差は観察されず，16～18歳の範囲では（P＜0.05）の有意差が認められ，ここでは男児のものが大きかった．英国白人との比較においても英国人とは異なるデータが得られた．