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CRANIAL NONMETRIC VARIATION OF MODERN KOREANS

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Abstract. *In this study we present the results of cranial non-metric examination of modern Korean population. Cranial sample of modern Koreans, housed at the Department of Anatomy, Medical College of Korea University,South Korea was investigated for cranial and mandibular nonmetric traits. The sample consisted of 34 complete skulls, 38 skulls without mandible, 28 cranial vaults and 34 separate mandibles of 92 males and 38 females with ages ranging from infantile I to senile. Fifty nine discrete cranial traits were analyzed with respect to sex and side differences and frequency distributions.*

Results of the study show no significant sex and side differences in the frequencies of the cranial nonmetric traits. Tendency for sex difference was observed in the occipital torus expression and for the presence of the sutura incisive. Not statistically significant side difference was found for the presence of the parietal foramen, hypoglossal canal bridging, mylohyoid bridging and mandibular torus. Highly significant side to side correlation was found for the most of the traits ($p<0.01$). Insignificant correlation coefficients were found for zygomatico-facial foramen absent, epipteric bone, parietal foramen, foramen ovale incomplete, foramen spinosum open, jugular foramen bridging, clinoid bridging and accessory mental foramen.

Cranial nonmetric, i.e. epigenetic variation, is quite popular in analyzing osteological materials at the population level and has successfully been used to evaluate the evolutionary relations and biological affinities among ancient and contemporary populations from different regions in the world (Finnegan and Marcsik 1979; Hanihara and Ishida 2001a; 2001b; 2001c; 2001d; 2001e; Hanihara et al. 1998; Ishida and Dodo 1992; 1993; 1997; Kozintsev 1972; Ossenberg 1990; Sutter and Mertz 2004; Wenger 1974). The theoretical basis of any such investigation is that 1) the traits are highly genetic in nature; 2) that populations vary in frequencies between even closely related populations; 3) that some consistency is seen without regard to environmental variation; 4) the traits do not vary significantly with age; 5) show little sex difference; 6) show little correlation between the traits used; and 7) are easily defined and have the advantage of being scoreable for highly fragmented skeletal materials.

The number of studies conducted on ancient and contemporary populations, however, raised various problems in the use of these traits in human population studies. One of such problems lays in the different viewpoints between authors on the sex difference of these traits. Many researchers found sex dependence of discontinuous traits in their research and believe that the sexes must be kept separate in the analysis of these traits (Berry 1975; Ossenberg 1976). A similar situation exists with respect to laterality of the expression of these traits (Konigsberg 1990).

In this paper we present the results of cranial non-metric examination of modern Korean population. Through extensive investigation involving 59 cranial nonmetric traits we aimed to reveal sex and side dependence of discontinuous traits in the cranial series of modern Korean.

Several works have been published on the results of cranial nonmetric trait researches of Koreans. These studies were conducted mainly, for medical and dental application. Nevertheless, some comparative analyses of cranial nonmetric traits can be found with the calculations of biological distances between Koreans and other Asian populations (Park et al., 2001).

Sir W S and Chung In Hyuk (1987), and Sir W S et al. (1989) studied nonmetrical variations of the occipital bone and skull foramina of Korean adults and incidences of the morphological variations were compared to those of 9 and 12 different geographical groups.

Kim H J and co-authors (1997) examined metric and nonmetric traits on zygomatic bones of 192 skulls (122 males, 43 females, and unknown 27 cases) of Koreans. According to their research, the incidences of the absence of the zygomaticofacial and the zygomaticotemporal foramina were 12.0% and 7.3%, respectively. The average number of the zygomaticofacial and the zygomaticotemporal foramina was 1.7 and 0.8, respectively. In most cases these foramina are located on the bodies of the zygomatic bone, and rarely on the frontal process of the zygomatic bone or on the borderline of the body and frontal process (Kim et al. 1997).

The locational relationship of supraorbital notch/foramen, infraorbital and mental foramina of Koreans were studied for clinical purpose by Chung M S and others (1995). Koh Ki Seok (2000) studied asymmetry of cranial nonmetric traits of Korean adults. Mandibular nonmetric traits by 13 criteria including chin and mental spine shape were examined by Hu K S and others (2000). Researchers observed strong sexual difference in the contour of mandibular lower border, as a "rocker form" was predominant for males (68.1%) and a

“straight form”- for females (82%). Mylohyoid canal was observed in 5% of the studied group (Hu K S, 2000).

Park D K and others (2001) investigated thirty nine cranial nonmetric traits of modern Koreans and compared with those of eighteen human populations. According to their results, Koreans have the highest incidence of the accessory infraorbital foramen (18%) among all populations compared. The sutural infraorbital foramen, posterior ethmoidal foramen absent, ear exotosis, temporal ossicle and bregmatic bone were not observed in the Korean sample. The distance analyses (MMD; mean value of divergence) revealed that the Koreans are closely related to Kazach and Mongolian than to Chinese and Japanese.

Examining morphology and location of the pterion in cranial sample consisting of 149 skulls, Lee U Y and others (2001) found, that the most common form of the pterion was a sphenoparietal articulation with frequencies of 76.5%. Incidence of the most common form of epipteric bone – single bone articulating with all the four bones at the area - was 40.3%.

MATERIALS AND METHODS

Cranial sample of modern Koreans, housed at the Department of Anatomy, Medical College of Korea University, was investigated for cranial and mandibular nonmetric traits. The sample consisted of 34 complete skulls, 38 skulls without mandible, 28 cranial vaults and 34 separate mandibles of 92 males and 38 females with ages ranging from infantile I to senile. The **Table 1** provides information on the age at death of the individuals examined for the cranial nonmetric traits.

Table 1. Age distribution of the examined skulls

Age	Frequency	Percent
Infantilis I	2	1.5
infantilisII	2	1.5
juvenis	4	3.0
adultus	75	56.0
maturus	46	34.3
senilis	2	1.5
Total	134	100.0

Fifty nine discrete cranial traits were analyzed with respect to sex and side differences and frequency distributions. The traits were selected based on their successful use by other researchers, and their scoring procedures and descriptions are well known in the literature (Finnegan and Marcsik, 1979; Hauser and DeStefano, 1989; Movsesyan et al., 1975) and for

criteria and nomenclatures of the variants we followed those authors. References for the scoring of each trait are given in the **Table 2**.

Table 2. Nonmetric cranial traits examined in the present study

No	Cranial nonmetric traits	Trait description	Notes
1	Metopic suture	Hauser and DeStefano, 1989	
2	Frontal groove	Hauser and DeStefano, 1989	
3	Supraorbital foramen	Hauser and DeStefano, 1989	
4	Trochlear spur	Hauser and DeStefano, 1989	
5	Anterior ethmoid foramen exsutural	Hauser and DeStefano, 1989	
6	Posterior ethmoid foramen absent	Hauser and DeStefano, 1989	
7	Accessory optic canal	Movsesyan et. al., 1975	
8	Accessory infraorbital foramen	Hauser and DeStefano, 1989	
9	Infraorbital suture	Hauser and DeStefano, 1989	
10	Zygomatico-facial foramen absent	Hauser and DeStefano, 1989	
11	Transverse zygomatic suture	Hauser and DeStefano, 1989	
12	Auditory torus	Hauser and DeStefano, 1989	
13	Tympanic dehiscence	Hauser and DeStefano, 1989	
14	Fronto-temporal articulation	Hauser and DeStefano, 1989	
15	Epipteric bone	Hauser and DeStefano, 1989	
16	Wormian bone at squamous suture	Hauser and DeStefano, 1989	
17	Parietal foramen	Hauser and DeStefano, 1989	
18	Parietal notch bone	Hauser and DeStefano, 1989	
19	Asterionic bone	Hauser and DeStefano, 1989	
20	Coronal ossicle	Hauser and DeStefano, 1989	
21	Ossicle at bregma	Hauser and DeStefano, 1989	
22	Sagittal ossicle	Hauser and DeStefano, 1989	
23	Ossicle at lambda	Hauser and DeStefano, 1989	
24	Lambdoid ossicle	Hauser and DeStefano, 1989	Graded
25	Occipitomastoid wormians	Hauser and DeStefano, 1989	Graded
26	Inca bone	Hauser and DeStefano, 1989	Graded
27	Interparietal process	Movsesyan et. al., 1975	
28	Biasterionic suture	Hauser and DeStefano, 1989	
29	Highest nuchal line	Hauser and DeStefano, 1989	
30	Occipital torus	Movsesyan et. al., 1975	
31	Palatine torus	Movsesyan et. al., 1975	
32	Maxillary torus	Hauser and DeStefano, 1989	
33	Sutura incisiva	Movsesyan et. al., 1975	
34	Medial palatine canal	Hauser and DeStefano, 1989	
35	Accessory lesser palatine foramina	Hauser and DeStefano, 1989	
36	Foramen ovale incomplete	Hauser and DeStefano, 1989	
37	Foramen spinosum open	Hauser and DeStefano, 1989	
38	Foramen spinosum absent	Hauser and DeStefano, 1989	
39	Ovale-spinosum confluence	Hauser and DeStefano, 1989	
40	Foramen of Vesalius	Hauser and DeStefano, 1989	
41	Pterygo-spinous foramen	Hauser and DeStefano, 1989	
42	Pterigo-alar foramen	Hauser and DeStefano, 1989	
43	Pharyngeal fossa	Hauser and DeStefano, 1989	
44	Condylus tertius	Hauser and DeStefano, 1989	
45	Precondylar tubercle	Hauser and DeStefano, 1989	
46	Condylar facet double	Hauser and DeStefano, 1989	
47	Hypoglossal canal bridging	Hauser and DeStefano, 1989	
48	Condylar canal patent	Hauser and DeStefano, 1989	
49	Sagittal sinus groove flexes left	Movsesyan et. al., 1975	
50	Jugular foramen bridging	Hauser and DeStefano, 1989	

51	Digastric groove doubled	Finnegan and Marcsik, 1979	
52	Manifestation of vertebra in occipital	Movsesyan et. al., 1975	
53	Mastoid foramen absent	Hauser and DeStefano, 1989	
54	Mastoid foramen exsutural	Hauser and DeStefano, 1989	
55	Clinoid bridging	Hauser and DeStefano, 1989	
56	Mandibular foramen double	Hauser and DeStefano, 1989	
57	Mylohyoid bridging	Hauser and DeStefano, 1989	
58	Mandibular torus	Hauser and DeStefano, 1989	
59	Accessory mental foramen	Hauser and DeStefano, 1989	

Nonmetric cranial trait frequencies were calculated using the "individual count" method described by Turner and Scott (1977), where if an individual exhibited asymmetry in the expression of a given trait, the greatest level of expression is used.

For each trait, sex and side differences were tested by χ^2 test using quick formula for 2x2 table. In cases where the expected number was less than 5 in any cell, to give better approximation to the exact probability, the following quick formula was used:

$$\chi^2 = \frac{n(|ad - bc| - n/2)^2}{(a+c)(b+d)(a+b)(c+d)}$$

Pearson correlation coefficient was used to evaluate right and left side correlation.

Data entry and statistical calculations were performed on the PC "Samsung" of the Institute for Archaeology and Environment of Korea University. Statistical calculations of cranial nonmetric trait frequencies and its sex and side differences were conducted using SPSS.12 program and visual expressions of the trait frequencies were performed on the MS Excel program.

RESULTS AND DISCUSSION

Within population variation of cranial nonmetric traits of modern Koreans

Although significant difference in the occurrence of the occipital torus was observed between males and females of Korea, sex-combined frequencies for each trait have been calculated. This calculation was based on the assumption that the trend in the expression of these traits in relation to sex is rather variable in different populations (Brazili et al. 1999). Incidences of 59 cranial nonmetric traits examined in the studied sample of modern Koreans are given in the **Table 3.** Traits are listed in descending order. Photos of nonmetric trait incidences are given in the Figures 1 to 32.

The most common trait observed in modern Korean cranial series is occipital torus (Fig. 1). The trait is observed with different levels of expression in 95.5% of all the examined skulls. Although this trait is usually omitted in cranial nonmetric trait researches, we distinguished trace, medium, strong and extreme levels of expression of the traits according to Movsesyan (1975) and found frequencies of 23.9%, 31.3%, 32.8% and 12.0% respectively.

Other common traits are parietal foramen, posterior condylar canal, mastoid foramen exsutural and anterior ethmoid foramen exsutural, with relative frequencies ranging from 0.782 to 0.877. We observed two cases of two foramina at the same side on the parietal. Position of exsutural mastoid foramen was distinguished separately in both sides. Among different positions of this foramen the mastoid location was predominant: 66.1 and 64.4% (right and left sides respectively) were situated in mastoid process of temporal bone, 1.7 and 3.4% - in the lateral part of the occipital bone, and 5.1 and 6.8% were of temporal-sutural location (more than one foramina in two different positions). Relatively high frequencies were observed for anterior ethmoid foramen exsutural (78.2%) and foramen of Vesalius (69.1%).

More than a half of the examined skulls revealed highest nuchal line, supraorbital foramen and digastric groove doubled. The highest nuchal line was scored according to their expression as trace, medium, strong and extreme (Hauser, De Stefano 1989). The prevalent expressions of highest nuchal line among Koreans are the medium and the trace development occurring in 45.5% and 40.9% respectively. 7 cases (10.6%) of the strong expression and no case of the extreme development of the highest nuchal line were detected.

We scored only medial supraorbital foramen (not taking into consideration a supraorbital notch) and ignored frontal foramen (additional foramen usually situated laterally from the supraorbital foramen). Half of the skulls examined showed the presence of this trait in the relative frequency of 0.515. We included into our research digastric groove doubled as an epigenetic trait and scoring was conducted according to Finnegan and Marcsik (1979). We find it is worth to note the relatively higher frequency (50.0%) of this trait among modern Koreans in comparison with the Mongolian sample (Erdene 2003; 2005a; 2005b).

Palatine torus is observed in 45.5% of the examined skulls. Scoring of this trait was made by Movsesyan classification: trace or *discontinuous*, medium or *continuous slightly elevated* and strong or *continuous highly elevated* types were determined (Movsesyan et al. 1975). Half of 30 cases of palatine torus in the sample were of the medium expression (*slightly elevated formation along the midline*) and another half was of the trace expression (*discontinuous elevation*). No case of *continuous highly elevated formation* was observed in the series studied (Fig. 2).

Table 3. Incidences of cranial nonmetric traits examined in the sample of modern Koreans

	Cranial nonmetric traits	Absent	Present	Total	Freq (p)
1	Occipital torus	3	64	67	0.955
2	Parietal foramen	8	57	65	0.877
3	Condylar canal patent	12	55	67	0.821
4	Mastoid foramen exsutural	12	47	59	0.797
5	Anterior ethmoid foramen exsutural	12	43	55	0.782
6	Foramen of Vesalius	21	47	68	0.691
7	Highest nuchal line	29	37	66	0.561
8	Supraorbital foramen	33	35	68	0.515
9	Digastric groove doubled	33	33	66	0.500
10	Palatine torus	36	30	66	0.455
11	Infraorbital suture	38	30	68	0.441
12	Accessory lesser palatine foramina	39	29	68	0.426
13	Lambdoid ossicle	46	23	69	0.333
14	Pharyngeal fossa	46	21	67	0.313
15	Sagittal sinus groove flexes left	52	17	69	0.246
16	Hypoglossal canal bridging	51	16	67	0.239
17	Mandibular torus	51	16	67	0.239
18	Parietal notch bone	53	14	67	0.209
19	Asterionic bone	53	14	67	0.209
20	Sutura incisiva	53	14	67	0.209
21	Accessory infraorbital foramen	55	13	68	0.191
22	Transverse zygomatic suture	56	12	68	0.176
23	Foramen spinosum open	57	11	68	0.162
24	Tympanic dehiscence	59	9	68	0.132
25	Frontal groove	67	10	77	0.130
26	Epipteric bone	55	8	63	0.127
27	Occipitomastoid wormians	57	8	65	0.123
28	Jugular foramen bridging	58	8	66	0.121
29	Trochlear spur	60	8	68	0.118
30	Foramen ovale incomplete	60	8	68	0.118
31	Ossicle at lambda	54	7	61	0.115
32	Mastoid foramen absent	59	7	66	0.106
33	Accessory mental foramen	59	7	66	0.106
34	Precondylar tubercle	61	6	67	0.090
35	Biasterionic suture	62	5	67	0.075
36	Clinoid bridging	47	3	50	0.060

37	Maxillary torus	63	4	67	0.060
38	Mylohyoid bridging	63	4	67	0.060
39	Interparietal process	58	3	61	0.049
40	Fronto-temporal articulation	63	3	66	0.045
41	Medial palatine canal	63	3	66	0.045
42	Mandibular foramen double	64	3	67	0.045
43	Accessory optic canal	61	2	63	0.032
44	Sagittal ossicle	63	2	65	0.031
45	Condylar facet double	65	2	67	0.030
46	Ovale-spinosum confluence	67	2	69	0.029
47	Coronal ossicle	63	1	64	0.016
48	Ossicle at bregma	63	1	64	0.016
49	Posterior ethmoid foramen absent	64	1	65	0.015
50	Assimilation of the atlas with the occipital bone	64	1	65	0.015
51	Condylus tertius	66	1	67	0.015
52	Zygomatico-facial foramen absent	67	1	68	0.015
53	Auditory torus	67	1	68	0.015
54	Pterygo-spinous foramen	67	1	68	0.015
55	Wormian bone at squamous suture	68	1	69	0.014
56	Metopic suture	92	1	93	0.011
57	Inca bone	67	0	67	0.000
58	Foramen spinosum absent	68	0	68	0.000
59	Pterigo-alar foramen	68	0	68	0.000

We observed 44.1% occurrence of a persisting infraorbital suture in the modern Korean sample. Facial persistence of the infraorbital suture was recorded as present, not taking into consideration its different types of forms or shapes (Fig. 3). Close to that of the infraorbital foramen frequency was observed for accessory lesser palatine foramina – 0.426 (Fig. 4).

In the third of the modern Korean sample we observed lambdoid ossicle and pharyngeal fossa. Example of the pharyngeal fossa cases is shown in the Fig. 5. We found that one fourth of the sample had sagittal sinus groove flexing left, hypoglossal canal bridging and mandibular torus. Relating the sagittal sinus groove we distinguished several types: flexing right, flexing left, branched and unclear. Results of the study show the following percentages for each type of the sagittal sinus groove: 55.07, 24.64, 13.04 and 7.25 respectively (Fig. 6). Hypoglossal canal bridging and mandibular torus were observed more

frequently on the left side, though chi-square test did not relieve significant side difference in the occurring of these traits. Photos of the traits are given in the Fig. 7 and 8.

Parietal notch bone, asterionic bone and sutura incisiva occurred with the same frequency 0.209. Cases of different types of wormian bones are in the Fig. 9 and sutura incisiva – is in the Fig. 10. Photos of the cranial nonmetric traits occurred with the frequencies ranging from 0.200 to 0.050 are given in the Fig. 11 to 21.

Fronto-temporal articulation or pterion form was determined for both sides in each skull. We observed only one case of X-shape (sutural connection of frontal and temporal bones at one point) at the left side of the skull #13a. An epipteric bone was detected locating above the articulation in this skull (Fig. 22). Two cases of K-shape fronto-temporal articulation were observed. In the skull #4 clear observable frontal process of temporal bone is detected in the left side. Another case of K-shape pterion seems less clear as a result of a complete fusion of fronto-parietal suture in the skull #4b. Nevertheless, more detailed examination lead the case to be identified as K-shape – temporal process of the frontal bone in the left side.

Other traits occurring with the frequencies less than 0.05 are interparietal process, medial palatine canal and mandibular foramen double; we observed three cases for each trait. According to Movsesyan et al., (1975), protrusion of the occipital squamae (*pars incoidea squamae occipitalis*) in lambda suture to sagiittal direction is identified as Interparietal process (Fig. 23). This trait can also be identified as the partial expression of Inca bone (Hauser DeStafano, 1989). Photos of cases of the medial palatine canal and the mandibular foramen double are given in the Fig. 24 and 25.

There are two cases for each of the following traits: accessory optic canal (Fig. 26), sagittal ossicle (Fig. 9), condylar facet double (Fig. 27) and ovale-spinosum confluence (Fig. 15). The rarest traits observed in the modern Korean cranial sample are coronal ossicle, ossicle at bregma, posterior ethmoid foramen absent, manifestation of vertebra in the occipital bone (Fig. 28), condylus tertius (Fig. 29), auditory torus (Fig. 30), pterigo-spinous foramen (Fig. 31), metopic suture (Fig. 32) and wormian bone at squamous suture – only one case for each of the traits was observed. We observed one case of bilateral absence of zygomatico-facial foramen, though there were five cases of unilateral zygomatico-facial foramen absence for each side. We found no case of Inca bone, foramen spinosum absent and pterigo-alar foramen in the cranial series of modern Koreans.

Results of the present study are compared to those obtained by Sir W S and Chung In Hyuk (1989) and Park D K et al. (2001) in nonmetric study of Korean. But, due to different

counting methods used in Sir W S et al.'s and Park et al.'s research, it is assumed not available to compare the data of total frequencies of cranial nonmetric traits and, instead, we compared here frequencies of the traits for left and right sides.

All the studies show quite alike frequencies of cranial nonmetric trait occurrence, except anterior ethmoid foramen exsutural and digastric groove doubled. Frequencies of these traits are much higher in the present study – 70.0% for anterior ethmoid foramen exsutural and 44.6% for digastric groove doubled. Nonetheless, paired t test analysis of 28 cranial nonmetric trait frequencies from the present and the Park et al.'s (2001) study revealed no interobserver difference ($p>0.05$).

Sex difference

Sex difference of 65 cranial nonmetric traits of modern Koreans was studied using χ^2 analyses and Fisher's exact probability test. With the exception of the occipital torus expression, no statistically significant difference was observed between male and female cranial samples. Occipital torus is expressed much stronger among males than females, showing significant result with χ^2 (4, n = 67) = 13.98, $p<0.05$. In contrast to the females, where trace and medium expressions dominated (80.0%), half of the male skulls show strong and extreme development of the trait. Incidences of various types of transverse palatine suture tend to be different in male and female subjects, χ^2 (6, n = 64) = 12.48, $p>0.05$, been more frequent for anterior or posterior convexed and zigzag types of the trait for males. Tendency for sex difference was observed also for the presence of the sutura incisiva, showing relatively higher incidence in females (χ^2 (1, n = 67) = 3.20, $p>0.05$).

Side difference

Side difference of 44 paired nonmetric traits was tested by χ^2 test. Frequencies of all the traits do not differ significantly between right and left sides. Not statistically significant side difference was found for the presence of the parietal foramen, hypoglossal canal bridging, mylohyoid bridging and mandibular torus. Parietal foramen tends to occur more on the right side (χ^2 = 2.2851, df = 1), while hypoglossal canal bridging and mandibular torus observed more frequently on the left side (χ^2 = 2.0329, df = 1). Cases of mandibular foramen double and mylohiod bridging are observed only on the right side, while wormian bone at squamous suture was observed only on the left side. But, χ^2 test shows any significant side preference in the case of unilateral expression of a trait. Table 4 gives the distribution of cranial nonmetric trait frequencies by side.

We also ascertained whether there are differences in the symmetric expression of the traits. Pearson correlation coefficients between right and left side occurrence of a trait per cranium were significant at the 0.01 level for the most of the traits, indicating a strong tendency to the same expression of the nonmetric traits on both sides. This aspect agrees with what has been observed in the other populations (Green et al. 1979; Ossenberg 1981; Brazili et al. 1999). Insignificant correlation coefficients were found for zygomatico-facial foramen absent, epipteric bone, parietal foramen, foramen ovale incomplete, foramen spinosum open, jugular foramen bridging, clinoid bridging and accessory mental foramen. The incidences of zygomatico-facial foramen absent and clinoid bridging could be explained by the small sample size (Ossenberg 1970): the traits were observed in one and three cases respectively among 68 skulls studied. A similar to ours result was obtained by Brazili et al. (1999) for the epipteric bone occurrence: significantly higher frequency of this trait was observed on the right side.

Table 4. Distribution of cranial nonmetric trait frequencies by side

Traits		right	left	Chi-square
Frontal groove	absent	71	68	
	present	6	9	0.6647
Supraorbital foramen	absent	43	42	
	present	25	26	0.0314
Trochlear spur	absent	61	62	
	present	7	6	0.0851
Anterior ethmoid foramen exsutural	absent	15	11	
	present	35	42	1.1654
Posterior ethmoid foramen absent	absent	61	64	
	present	1	1	0.4614
Accessory optic canal	absent	60	60	
	present	2	2	0.2583
Accessory infraorbital foramen	absent	57	61	
	present	11	7	1.0245
Infraorbital suture	absent	47	41	
	present	21	27	1.1591
Zygomatico-facial foramen absent	absent	61	62	
	present	5	5	0.0925
Transverse zygomatic suture	absent	58	60	
	present	8	7	0.0931
Auditory torus	absent	64	65	
	present	1	1	0.4924
Tympanic dehiscence	absent	60	59	
	present	6	7	0.0853
Fronto-temporal articulation	k	1	1	
	x	0	1	1.0578
Epipteric bone	absent	55	60	

	present	6	2	1.2561
Wormian bone at squamous suture	absent	66	65	
	present	0	1	0.0000
Parietal foramen	absent	24	26	
	present	41	37	
Parietal notch bone	absent	55	56	
	present	11	9	0.2014
Asterionic bone	absent	57	54	
	present	9	11	0.2735
Coronal ossicle	absent	57	57	
	present	1	1	0.5088
Lambdoid ossicle	absent	50	48	
	present	17	19	0.1519
Occipitomastoid bone	absent	60	59	
	present	5	5	0.0007
Biasterionic suture	absent	63	62	
	present	4	3	0.0017
Maxillary torus	absence	63	64	
	present	4	2	0.1592
Sutura incisiva	absent	54	55	
	present	13	12	0.0492
Medial palatine canal	absent	63	66	
	present	3	0	1.3643
Accessory lesser palatine foramina	absent	49	44	
	present	18	24	1.1186
Foramen ovale incomplete	absent	61	66	
	present	6	2	1.2436
Foramen spinosum open	absent	62	60	
	present	5	7	0.3661
Ovale-spinosum confluence	absent	66	67	
	present	2	1	0.0000
Foramen of Vesalius	absent	26	33	
	present	41	35	0.9318
Foramina Civinini	absent	67	67	
	present	0	1	0.0001
Precondylar tubercle	absent	61	61	
	present	6	6	0.0915
Condylar facet double	absence	65	66	
	present	2	1	0.0000
Hypoglossal canal bridging	absent	60	53	
	present	7	14	2.7670
Condylar canal patent	absent	21	22	
	present	46	44	0.0036
Jugular foramen bridging	absent	61	60	
	present	4	4	0.1173
Digastric groove doubled	absent	36	38	
	present	29	27	0.1255
Mastoid foramen absent	absent	60	59	
	present	5	6	0.0993
Mastoid foramen exsutural	mastoid	39	38	
	occipital	1	2	

	mastoid-sutural	3	4	0.5214
Clinoid bridging	absent	46	46	
	present	2	1	0.0003
Mandibular foramen double	absent	63	66	
	present	3	0	1.3643
Mylohyoid bridging	absent	62	66	
	present	4	0	2.3203
Mandibular torus	absent	55	51	
	weak	7	10	
	medium	5	4	
	strong	0	2	2.7915
Accessory mental foramen	absent	62	65	
	present	5	2	0.6029

CONCLUSION

The frequency of nonmetric traits in the sample of modern Koreans shows the most common traits are *occipital torus, parietal foramen, condylar canal patent, mastoid foramen exsutural, anterior ethmoid foramen exsutural, foramen of Vesalius, highest nuchal line, supraorbital foramen, digastric groove doubled and the rarest are coronal ossicle, ossicle at bregma, posterior ethmoid foramen absent, assimilation of the atlas with the occipital bone, condylus tertius, zygomatico-facial foramen absent, auditory torus, pterygo-spinous foramen, wormian bone at squamous suture, metopic suture.* We found no case of *Inca bone*, *foramen spinosum absent* and *pterigo-alar foramen* in the cranial series of modern Koreans.

There is almost complete overlap of the sexes for the most of the cranial nonmetric trait frequencies. Tendency for sex difference was observed in the *occipital torus expression* and for the *presence of the sutura incisive.*

Not statistically significant side difference was found for the presence of the *parietal foramen, hypoglossal canal bridging, mylohyoid bridging* and *mandibular torus*.

Highly significant side to side correlation was found for the most of the traits ($p<0.01$). Insignificant correlation coefficients were found for *zygomatico-facial foramen absent, epipteric bone, parietal foramen, foramen ovale incomplete, foramen spinosum open, jugular foramen bridging, clinoid bridging* and *accessory mental foramen*.

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ХУРААНГУЙ

М.Эрдэнэ

ОРЧИН ҮЕИЙН СОЛОНГОСЧУУДЫН ГАВЛЫН ЭПИГЕНЕТИК ШИНЖҮҮДИЙН СУДАЛГАА

Орчин үеийн Солонгосчуудын 70 гаруй толгойн ясанд эпигенетикийн 59 шинжийг хүйс болон баруун зүүн талаар нь харьцуулан судаллаа. Судалгааны дүнгээс харахад эпигенетик шинжийн хүйсийн болон баруун зүүн талын тархалтанд статистик магадлалтай ялгаа ажиглагдахгүй ч зарим хандлага тэмдэглэгдлээ. Дагзны гаднах төвгөрийн хөгжил, үүдэн шүдний заадал зэрэг шинжүүдэд хүйсийн ялгаа илрэх хандлагатай байв. Зулайн нүх голдуу баруун талдаа тохиолдож байсан бол хэлний доод мэдрүүлийн суваг салаалах, эрүүний торус зэрэг шинжүүд ихэвчлэн зүүн талд ажиглагдаж байв. Ихэнх шинжүүдийн баруун зүүн талуудын хооронд өндөр магадлалтай корреляц ($p<0.001$) ажиглагдлаа. Харин хацар ясанд нүхгүй байх, эпиптерик яс, зулайн нүх, зууван ба арын нүх нээлттэй байх, буулгын нүх хуваагдах, шаантаг сэртэн битүүрэх, оочны нүх салаалах зэрэг шинжүүдийн баруун зүүн талуудын хооронд магадлалтай корреляц ажиглагдсангүй.

CRANIAL NONMETRIC TRAIT INCIDENCES OBSERVED IN THE SAMPLE OF MODERN KOREANS

Fig. 1. Occipital torus #4b. Strong expression

Fig. 2. Palatine torus #19a. Palatine torus medium expression

Fig. 3. Infraorbital suture #16

Fig. 4. Accessory lesser palatine foramina #20

Fig. 5. Pharyngeal fossa #19

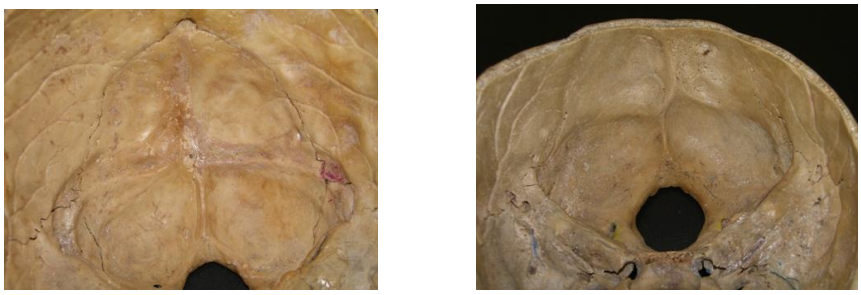


Fig. 6. Different variations of the sagittal sinus groove
#1. Sagittal sinus groove branched #4. Sagittal sinus groove unclear

#16. Sagittal sinus groove flexing right

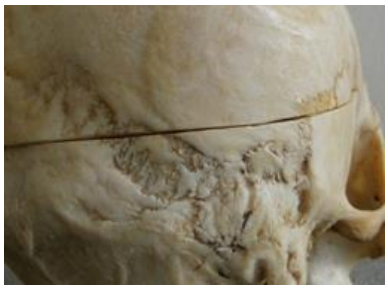
#20. Sagittal sinus groove flexing left

Fig. 7. Hypogglossal canal bridging #17

Fig. 8. Mandibular torus #2-2. Medium expression

Fig. 9. Wormian bones

#55. Sagittal ossicle



#4a. Asterionic & lambdoid bone

#7. Ossicle at the lambda

#14. Epipteric bone

#24. Asterionic & lambdoid bones

#33. Occipito-mastoid wormian

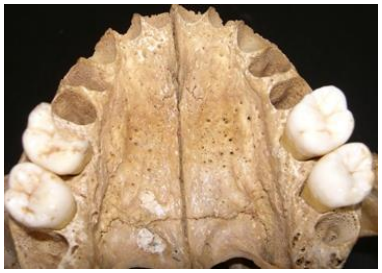


Fig. 10. Sutura incisiva #1

Fig. 11. Transverse zygomatic suture #5har

Fig. 12. Frontal groove #16

Fig. 13. Jugular foramen bridging #20 (left)

Fig. 14. Trochlear spur #9

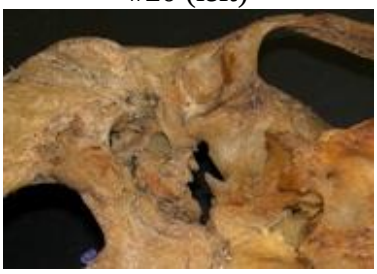
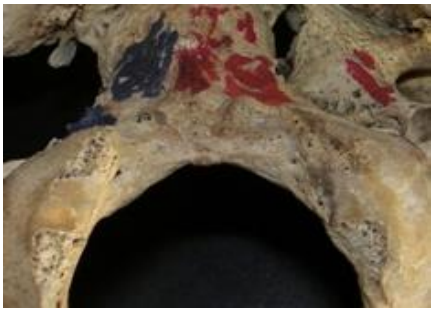


Fig. 15. Foramen ovale incomplete and ovale-spinosum confluence #35. Ovale incomplete (right)

Fig. 16. Accessory mental foramen #1-4 (right) #13a (left)

Fig. 17. Precondylar tubercle #4a #5har

#13a



#45

Fig. 18. Biasterionic suture
#4a #49

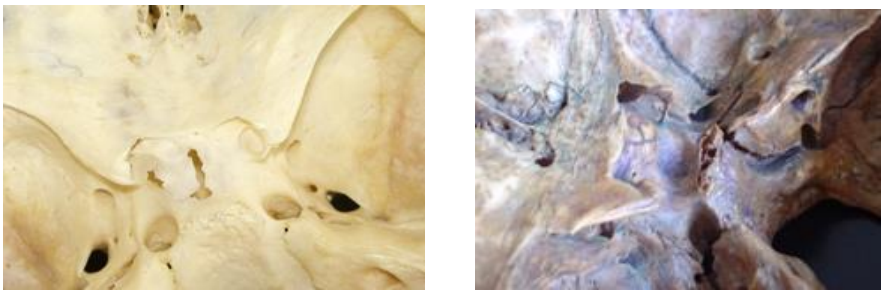


Fig. 19. Clinoid bridging
#1-4 #30

Fig. 20. Maxillar torus
#2-2 #2-2

Fig. 21. Mylohyoid bridging
#2-2 #7

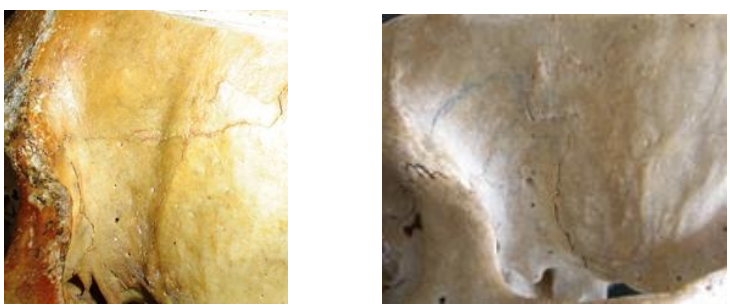


Fig. 22. Fronto-temporal articulation
#13a. X-shape pterion #4. K-shape pterion


Fig. 23. Interparietal process
#14 #19


Fig. 24. Palatine bridging
#21 #38


Fig. 25. Mandibular foramen double
#17

Fig. 26. Accessory optic canal
#81-3 (left)


Fig. 27. Condyle facet double
#19b

Fig. 28. Manifestation of vertebra at occipital
#23

Fig. 29. Condylius tertius #23

Fig. 30. Auditory torus #38

Fig. 31. Pterigo-spinous foramen #52

Fig. 32. Metopism #55