

## Dental and Facial Morphology of the Human Skeletons Unearthed at the Chandman Site in Western Mongolia

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**Abstract** Approximately fifty human skulls dating to the Bronze and early Iron Ages were recovered from the Chandman site in western Mongolia. The metric and nonmetric tooth traits data and the facial flatness measurements were taken and compared with those of the adjacent prehistoric and modern population samples. In both the dental and facial morphology, the Chandman people show closer resemblance to the Europeans including the West Asians rather than to the Mongolians, though partially have some similarity to the latter. The appearance of the European features in the Chandman crania and dentition indicate the invasion of Caucasians into western Mongolia, probably during the Bronze Age.

**Key words:** Mongolia, Chandman, Dentition, Skeleton, Facial flatness.

### Introduction

The Chandman site, locating in the suburb of the Ulaangom City in western Mongolia (Fig. 1), produced approximately 50 skeletal individuals ranging in date from the 7th century B.C. of the Bronze Age to the 3rd century B.C. of the early Iron Age. Although the present inhabitants in Mongolia are mostly composed of the East Asians, there live some Turkish nomads such as the Kirgiz and the Uigur. Probably since the Neolithic period, Central Asia, including Mongolia, had been the stage of territorial dispute between the East Asians and Europeans. From the point of view of such complicated Mongolian history, it is an interesting subject to reveal whether the Chandman people were affiliated to the East Asian lineage or the European one.

With this purpose in mind, therefore, the Chandman skeletons were investigated for the dental and facial skeletal morphology, and their affinities with neighboring Asian and European samples were evaluated using the data obtained.

### Materials and Methods

From the tooth samples of the Chandman skulls, mesiodistal and buccolingual

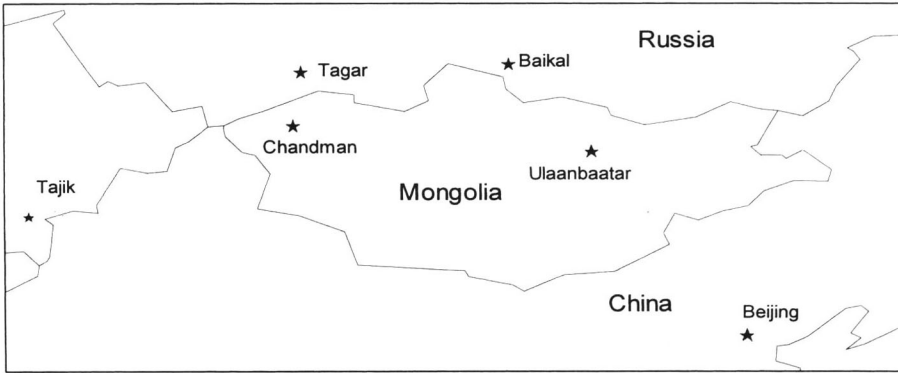


Fig. 1. Locality of the Chandman and comparative samples.

crown diameters were taken after the measurement method of Fujita (1949). Twenty-one nonmetric traits were also investigated in accordance with those standards of identifications shown in elsewhere (Matsumura, 1995). Both the metric and nonmetric traits data were taken from the right side tooth, or left side one in case the right side tooth missing.

Concerning the facial skeletal morphology, the degrees of prominence at the nasal root, the nasal roof and the subnasal region were investigated for the Chandman crania, since it is well known that these characteristics effectively discriminate the cranial samples of the East Asians and the Europeans. For this purpose, six measurements and three indices of facial flatness were taken after Yamaguchi's (1973) definitions.

For comparisons of the tooth measurements, the data of the Tajik (Sakai *et al.*, 1971) were used as the sample from the Caucasians geographically adjacent to western Mongolia. As for the nonmetric tooth traits, only the data stock collected by the present first author was used as comparison samples for eliminating interobserver error. Accordingly, the Saxons sample was the only Caucasian sample available for the comparison. From the modern East Asian samples, on the other hand, that of the Urga Mongolians (Matsumura, 1995) was selected for comparisons of both the metric and nonmetric traits data. For comparisons of the measurements and indices of facial flatness, the data of the Neolithic Baikilians, the Iron Age Tagar people from southeastern Siberia, and the modern Mongolians, Buryats and Russians were quoted from Ishida (1992).

## Dental Morphology

### *Metric Characteristics*

The basic statistics of the tooth crown measurements of the Chandman males

Table 1. Mesiodistal and buccolingual crown diameters of the Chandman dentition.

	Males			Females		
	n	M (mm)	SD	n	M (mm)	SD
Mesiodistal diameters						
UI1	7	8.60	0.60	1	8.23	0.00
UI2	7	6.92	0.75	2	7.12	0.84
UC	18	7.88	0.38	5	7.54	0.30
UP1	18	6.84	0.33	7	6.68	0.31
UP2	14	6.45	0.42	7	6.43	0.54
UM1	14	10.11	0.63	12	9.98	0.60
UM2	19	9.21	0.60	15	9.23	0.73
LI1	6	5.18	0.50	4	4.94	0.24
LI2	11	5.67	0.41	8	5.72	0.42
LC	11	6.85	0.42	6	6.78	0.47
LP1	17	6.80	0.36	8	6.89	0.34
LP2	17	6.69	0.51	9	6.79	0.25
LM1	14	11.18	0.51	13	11.19	0.74
LM2	18	10.66	0.54	14	10.62	0.77
Buccolingual diameters						
UI1	8	7.26	0.32	1	7.40	0.00
UI2	7	6.22	0.68	3	6.57	0.31
UC	17	8.52	0.39	8	8.11	0.59
UP1	18	9.28	0.41	4	8.95	0.56
UP2	15	9.38	0.45	7	9.02	0.41
UM1	18	11.75	0.41	13	11.49	0.68
UM2	18	11.52	0.64	13	11.26	0.79
LI1	10	5.83	0.32	4	5.67	0.28
LI2	12	6.29	0.17	10	6.14	0.36
LC	15	7.84	0.33	6	7.53	0.38
LP1	17	7.95	0.44	8	7.74	0.60
LP2	15	8.31	0.45	9	8.04	0.52
LM1	18	10.78	0.38	15	10.73	0.54
LM2	20	10.33	0.42	13	10.35	0.67

and females are given in Table 1. The comparisons of male mean values with the Urga Mongolians and the Tajik are shown in Table 2. The significant differences from the Urga Mongolians were found in 10 out of 28 measurements, where the Chandman people are smaller than the Urga Mongolians. Compared with the Tajik, on the other hand, the significant differences were observed in 15 out of 28 measurements. The Chandman people were larger than the Tajik in most of those mean values.

Figure 2 represents deviation diagrams of the mesiodistal crown measurements from the Urga Mongolians. It is reconfirmed that the overall tooth size of the Chandman people is smaller than that of the Urga Mongolians but slightly larger than that

Table 2. Comparisons of mesiodistal and buccolingual tooth crown diameters of the Chandman males with the Urga Mongolian and Tajik males.

	Chandman Males			Urga Mngolian Males			Tajik Males (Sakai <i>et al.</i> , 1971)				
	n	M (mm)	SD	n	M (mm)	SD	<i>t</i> -value	n	M (mm)	SD	<i>t</i> -value
Mesiodistal diameters											
UI1	7	8.60	0.60	23	8.40	0.63	0.74	36	8.34	0.22	2.053*
UI12	7	6.92	0.75	25	7.05	0.48	0.56	36	6.56	0.43	1.778
UC	18	7.88	0.38	42	7.87	0.39	0.09	36	7.59	0.11	4.270***
UP1	18	6.84	0.33	47	7.21	0.39	3.56***	36	6.59	0.15	3.844***
UP2	14	6.45	0.42	52	6.62	0.48	1.21	36	6.38	0.21	0.786
UM1	14	10.11	0.63	49	10.31	0.54	1.18	36	9.94	0.36	1.201
UM2	19	9.21	0.60	48	9.48	0.63	1.60	36	8.92	0.29	2.425*
LI1	6	5.18	0.50	26	5.32	0.43	0.70	36	5.12	0.13	0.634
LI2	11	5.67	0.41	27	6.06	0.35	2.97***	36	5.74	0.14	0.886
LC	11	6.85	0.42	45	7.07	0.36	1.76*	36	6.73	0.15	1.463
LP1	17	6.80	0.36	44	7.25	0.41	3.97***	36	6.64	0.13	2.378*
LP2	17	6.69	0.51	48	7.23	0.47	3.98**	36	6.93	0.20	2.470*
LM1	14	11.18	0.51	51	11.52	0.58	1.99*	36	10.64	0.33	4.429***
LM2	18	10.66	0.54	46	11.01	0.63	2.08**	36	9.82	0.33	7.086***
Buccolingual diameters											
UI1	8	7.26	0.32	25	7.31	0.48	0.27	36	7.31	0.38	0.345
UI2	7	6.22	0.68	28	6.67	0.44	2.16**	36	6.52	0.49	1.391
UC	17	8.52	0.39	28	8.40	0.48	0.87	36	8.21	0.50	2.250*
UP1	18	9.28	0.41	35	9.44	0.59	1.03	36	8.86	0.60	2.669*
UP2	15	9.38	0.45	39	9.18	0.55	1.25	36	8.79	0.54	3.721***
UM1	18	11.75	0.41	34	11.78	0.61	0.19	36	11.14	0.34	5.799***
UM2	18	11.52	0.64	35	11.60	0.62	0.44	36	11.26	0.44	1.752
LI1	10	5.83	0.32	28	5.92	0.31	0.78				
LI2	12	6.29	0.17	31	6.41	0.40	1.00				
LC	15	7.84	0.33	32	7.99	0.58	0.93	36	7.72	0.22	1.524
LP1	17	7.95	0.44	37	8.27	0.60	1.97*	36	7.62	0.26	3.426***
LP2	15	8.31	0.45	36	8.47	0.56	0.98	36	8.10	0.39	1.675
LM1	18	10.78	0.38	36	11.09	0.53	2.21**	36	10.47	0.25	3.594***
LM2	20	10.33	0.42	35	10.44	0.53	0.80	36	10.04	0.38	2.636*

Significance level: \* 5%, \*\* 1%, \*\*\* 0.5%.

of the Tajik. The deviation pattern of the Chandman people resembles that of the Tajik except in the molar class. In both the overall tooth size and proportion, the Chandman people show closer affinity to the Tajik rather than to the Urga Mongolians.

#### *Nonmetric Characteristics*

The frequencies of the 21 nonmetric tooth traits observed in the Chandman den-

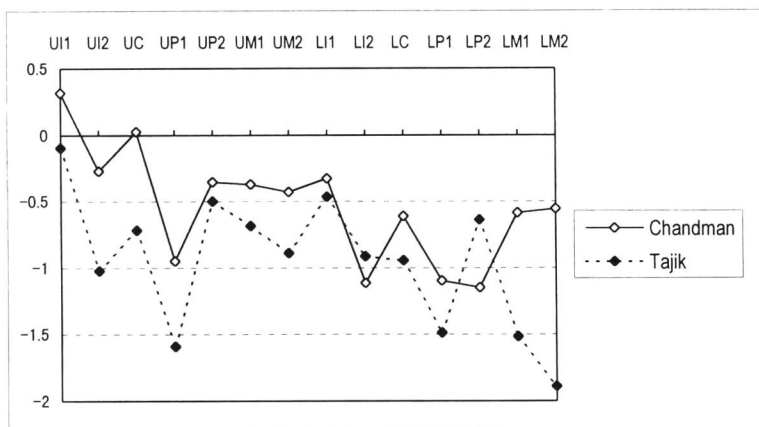


Fig. 2. Standardized deviations of the mesiodistal crown diameters in the Chandman and Tajik males from the Urga Mongolians.

tion are given in Table 3. The data of the Urga Mongolians and the Saxons are also shown in the same table together with the results of the chi-square tests evaluating the significance of differences from the Chandman people. In comparison with the Urga Mongolians, significant differences were detected in 5 traits of the 21 examined, while significant differences from the Saxons were observed in 4 traits.

As for the frequency of the shovel shaped incisor, the Chandman people were found to be intermediate between the Saxons with lower frequency and the Mongolians with higher frequency. The Carabelli's trait of the maxillary first molar was observed more frequently in the Chandman people than in the Urga Mongolians. This trait occurrence in the Chandman people is comparable with that in the Saxons. Concerning the hypocone reduction in the maxillary second molar and the hypoconulid reduction in the mandibular second molar, the incidences were higher in the Saxons than in the Urga Mongolians. Frequencies of the two trait in the Chandman people were as low as in the Urga Mongolians.

To sum up, the Chandman people proved to share the dental characteristics with the Europeans in respects of the rather low occurrence of the shovel shaped incisors and the high frequency of the Carabelli's traits in the maxillary first molars. On the contrary, the Chandman dentition bears Mongolian features as to the low frequencies of both the hypocone and hypoconulid reductions in the second molars.

### *Biological Distances*

The dental affinities between the Chandman people and the comparative population samples were evaluated by calculating biological distances based on the metric and nonmetric traits data. Euclidean distances were computed between the population samples, using the 14 mesiodistal crown diameters, and Smith's distances were calcu-

Table 3. Frequencies of presence of the 21 nonmetric traits in the Chandman dentition and results of com with those of the Urga mongolians and Saxons.

Nonmetric tooth trait		Chandman People		Urga Mongolians			Saxons		
		Freq. (%)	n	Freq. (%)	n	Chi-square	Freq. (%)	n	Chi-square
shovelling	UI1	33.3	9	83.9	31	8.935***	20.0	40	0.750
shovelling	UI2	40.0	10	81.1	37	6.640***	29.4	51	0.437
double shovelling	UI1	0.0	9	4.9	41	0.457	6.5	46	0.621
double shovelling	UI2	0.0	9	0.0	44	0.000	0.0	54	0.000
tuberculum dentale	UI1	10.0	10	2.1	48	1.558	14.0	43	0.111
tuberculum dentale	UI2	9.1	11	0.0	53	4.895*	9.8	51	0.005
spine	UI1	20.0	10	60.0	40	5.128*	48.8	41	2.715
interruption groove	UI2	30.0	10	34.8	46	0.000	34.0	47	0.060
winging (bilateral)	UI1	0.0	10	5.9	51	0.619	10.9	46	1.194
De Terra's tuberculum	UP1	27.8	18	53.6	69	3.819	1.8	55	12.115***
double rooted	UP1	40.0	30	29.4	34	0.792	67.9	28	4.517*
double rooted	UP2	10.0	30	0.0	22	2.335	20.0	20	0.997
Carabelli's trait	UM1	45.8	24	17.6	91	8.437***	33.3	48	1.067
hypocone reduction	UM2	16.1	31	23.5	85	0.736	49.2	65	9.709***
sixth cusp	LM1	9.5	21	18.0	61	0.848	0.0	38	3.746
seventh cusp	LM1	8.0	25	17.8	62	1.330	2.4	41	1.107
protostylid	LM1	3.8	26	11.7	60	1.315	0.0	37	1.446
deflecting wrinkle	LM1	12.5	16	34.0	47	2.714	5.0	20	0.655
groove pattern Y	LM1	85.5	20	72.6	62	1.265	77.4	31	0.443
groove pattern X	LM2	40.7	27	50.0	64	0.653	34.0	50	0.344
hypoconulid reduction	LM2	46.2	26	50.0	52	0.103	84.0	50	11.912***

lated using the 21 nonmetric traits frequencies. The results are given in Table 4. The Chandman people are closer to the Tajik in the Euclidean distance and to the Saxons in the Smith's distance rather than to the Urga Mongolians.

### Facial Flatness Measurements

Table 5 gives the basic statistics of the six measurements and three indices of facial flatness taken from the Chandman male skulls, together with the mean values of five comparative population samples cited from Ishida (1992).

Firstly, the frontal, simotic and zygomaxillary indices of the Chandman people were compared with those of the five population samples. In the frontal indices evaluating the protrusion of the nasal root, the Chandman people were found to be intermediate between the Russians and Mongolians. However, the simotic and zygomaxillary indices of the Chandman were as high as those of the Russians, showing that the Chandman people possessed the protruding nasal roof and the posteriorly positioned

Table 4. Biological distances between the Chandman and comparative population samples based on the metric and nonmetric tooth traits.

Euclidean distances based on the metric traits	
Chandman—Urga Mongolians	0.459
Chandman—Tajik	0.376
Urga Mongolians—Tajik	1.146
Smith's distances based on the nonmetric traits	
Chandman—Urga Mongolians	0.1853
Chandman—Saxons	0.1488
Urga Mongolians—Saxons	0.4622

Table 5. Measurements and indices of facial flatness of the Chandman males and comparative population samples.

	Chandman			Buryats*	N. Baikal*	Mongolians*	Russians*	Tagar*
	n	M	SD	M	M	M	M	M
Frontal chord	31	99.6	4.11	100.0	98.1	100.7	97.3	101.0
Frontal subtense	31	16.4	3.62	15.2	14.8	14.7	18.0	17.8
Frontal index	31	16.4	3.50	15.2	15.0	14.5	18.5	17.6
Simotic chord	31	9.1	2.16	8.0	7.6	7.5	9.3	8.5
Simotic subtense	31	4.4	1.35	3.0	3.0	3.1	4.1	4.5
Simotic index	31	48.9	1.50	37.3	39.9	41.1	44.7	53.8
Zygomaxillary chord	29	98.1	5.25	103.1	100.6	103.7	93.6	97.1
Zygomaxillary subtense	29	24.6	4.62	21.0	19.1	19.9	23.6	23.2
Zygomaxillary index	29	26.9	8.70	20.4	19.1	19.3	25.2	23.9

\*Cited from Ishida (1992).

Table 6. Penrose's shape distances based on the six measurements of facial flatness.

	Chandman	Buryats	N. Baikal	Mongol.	Russians
Buryats	0.508				
N. Baikalinas	0.353	0.041			
Mongolians	0.673	0.033	0.092		
Russians	0.211	1.127	0.841	1.411	
Tagar	0.095	0.590	0.406	0.705	0.237

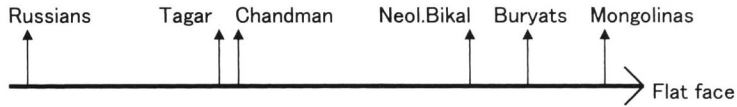


Fig. 3. Linear expression of MDS applied to the Penrose's shape distances based on the six measurements of facial flatness (Contribution 95%).

zygomaxillary region as observed in the European crania.

Secondly, the Penrose's shape distances between the Chandman people and comparative population samples were calculated on the basis of the six measurements of facial flatness, using the standard deviations of the Chandman sample. The results are shown in Table 6. The Chandman people are the closest to the Tagar sample, and quite distant from the modern Mongolians.

Figure 3 is the linear expression of the multidimensional scaling applied to the distance matrix of Table 6. The Russians are plotted on the left end of the axis because of bearing a very prominent face. On the contrary, the Neolithic Baikilians, modern Buryats and Mongolians are positioned at the right portion of the axis due to their strikingly flat face. The Chandman people, together with their closest neighbor, the Tagar sample, are situated intermediately between the Russians and Neolithic Baikilians.

### Discussion

According to Ishida (1994, 1995), the facial skeletons of the Neolithic western Siberians including the Baikilians were as flat as those observed in the typical modern Northeast Asians such as the Buryats. In the subsequent period, the facial skeletons had gradually protruded and became most protruding in the Bronze Age. Thereafter, the facial skeletons returned to be flat where they have remained up to the present. Such diachronic change of facial flatness is considered to be due to the temporary invasion of the Europeans into the territory of the "Mongoloid" people during the Bronze Age. In the western Mongolian region, too, if the Neolithic inhabitants belonged to the so-called "Mongoloid" people, a similar population history might be implied through the analysis of the Chandman skeletons of the subsequent ages.

Kozintsev (1977) and Ishida (1993) examined the Tagar specimens and found predominantly European features. The facial morphology of the Chandman crania, having the closest affinity with that of the Tagar crania, suggests that the Chandman people belonged to the Europeans. However, the facial skeletons of the Tagar and the Chandman people are slightly flatter in average than those of the Russians. In respect of the individual variation, strikingly protruding faces and contrastive flat faces coexist with each other in the Chandman cranial series (Fig. 4). Also in the dental morphology, the Chandman people show a closer resemblance to the Europeans rather



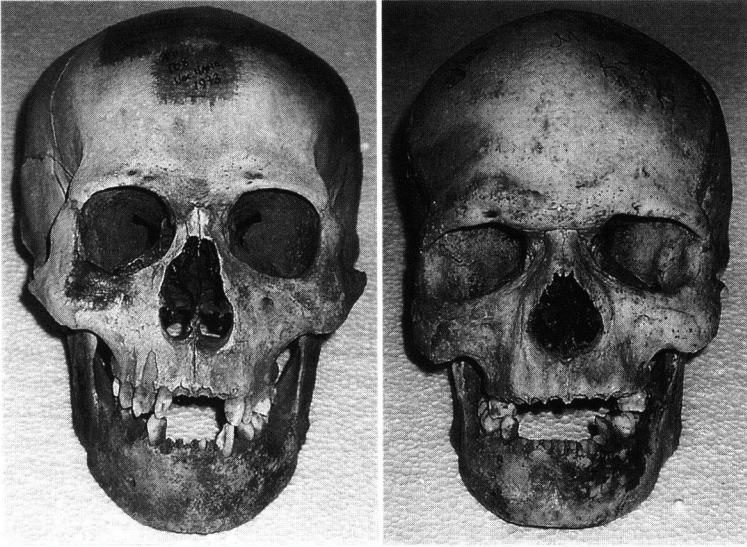


Fig. 4. Two representative human skulls from the Chandman site in Mongolia.  
Left: Male skull with the Mongoloid proportion, Right: Male skull with the Caucasoid proportion.

than to the Mongoloid sample, though partially they have some characteristics resembling the modern Mongolians. From these findings, it is inferred that the appearance of the European features in the Chandman crania and dentition was due to the invasion of the people of the Caucasian lineage into western Mongolia probably during the Bronze Age.

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