A Preliminary Study on Inherited Tooth Morphology Characters of Japanese and Chinese Young Adults — With Special Reference to the Carabelli Tubercle —

By

Yasutomo IWAI-LIAO, Lian GUO*, Yoshikage HIGASHI, Dalin SUN*, Takayoshi TSUBAI, Jae-Goo KIM and Masanori TAKEUCHI

Department of Oral Anatomy, Osaka Dental University and Department of Oral Anatomy, School of Stomatology, Shanghai 2nd Medical University*

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Summary: A comparative study on inherited tooth morphology characters, in particular the incidence of Carabelli tubercles in the maxillary dentition, was conducted on standardized stone casts obtained from 240 Japanese (124 males (♂) and 116 females (♀)) and 160 Chinese (74♂, 86♀) young adults. The following results were obtained: 1) No significant differences in the incidence of Carabelli tubercles according to sex or body height were found between the two groups. 2) However, significant differences in the incidence of Carabelli tubercles according to sex were found in both groups. The tubercles occurred more frequently in males. 3) Significant differences between the bilateral and unilateral occurrence of Carabelli tubercles were observed in both the Japanese ($p < 0.05$) and Chinese ($p < 0.01$) groups; Carabelli tubercles on upper first molars were always bilateral. 4) The highest incidence of Carabelli tubercles was found in individuals with a body height of 166–175 cm in both groups, and a significant difference ($p < 0.05$) between the 156–165 cm and 166–175 cm groups was particularly evident in the Japanese adults.

The authors postulate that bilateral occurrence of Carabelli tubercles was originally an inherited character in the molar region, but that the character was inhibited during the process of evolution of the masticatory system and regression of the molar dentition.

Many anatomical studies have suggested that certain morphological characteristics and various landmarks on teeth are inherited (acquired) characters, and among them, a high frequency of the occurrence of the “tuberculum anomalum” on the lingual aspect of the mesio-lingual cusp of maxillary molars has been reported in many studies. Later, the same landmark on the coronary surface was designated the familiar “Carabelli cusp” (Sakai, 1974; Fujita, 1995).

A study in the literature has stressed that Carabelli cusps occur more frequently in males than in females (Morrees, 1957), and a study on Carabelli cusps in different peoples states that they are frequently observed in the Caucasian, Afghan, African and American Indian, less often in the Japanese and Micronesian and even lesser in the Malaysian, Ainu and Polynesian, with Chinese having the most lowest incidence (Kieser, 1981). The heritability of the Carabelli cusp has also been mentioned because they have been found to be more prominent in dizygotic twins than in heterozygous twins (Biggerstaff, 1973). Furthermore, correlations between the occurrence

of Carabelli tubercle, shovel-shaped incisor, distal lingual marginal tubercle, median lingual accessory cusp, protostylid and deflecting wrinkle have been investigated and reported as the “dental complex”, representing anthropological characteristics of the tooth morphology (Uehara, 1992). A study has pointed out that the Carabelli cusp is an inherited character related to the phylogenesis of the tooth morphology, dentition and the gnatho-maxillofacial complex, and these characters are affected by environmental factors in different peoples (Xu, 1994).

In the present study, we prepared 400 sets of standardized plaster casts of the maxillary and mandibular dentition of both Japanese and Chinese young adults. Their teeth, dentition, dental arches and occlusion were examined and classified, and the distribution and frequency of landmarks supposed to be the acquired tooth characters were subsequently quantitatively-analyzed and compared based on the same categories and criteria. The present preliminary study in particular aimed at the Carabelli tubercle, because it has a high incidence in the “dental complex” in both the Japanese and Chinese groups.

Materials and Methods

Standardized study models (dental plaster casts of maxillary and mandibular dentitions) were obtained from second year students at Osaka Dental University and School of Stomatology, Shanghai Second Medical University. The Japanese group contained 124 (51.7%) males (σ) and 116 (48.3%) females (ϕ), the Chinese group contained 74 σ (46.3%) and 86 ϕ (53.7%). None of all the samples contained dentitions exhibiting clear hard tissue defects or were massively restored artificially (Table 1). The Chinese group in the present study contained only Han natives.

The morphology of the dental arches, occlusion, various inherited characters and morphological anomalies found on the tooth surfaces of each cast were examined repeatedly, at least three times by four different investigators, the results were diagnosed based on the same criteria and recorded in formulated charts. In the present preliminary study, we particularly investigated the Carabelli tubercle because it is a distinct landmark in the dental arches of both groups and noted that 94 individuals (23.5% of 400 samples) displayed Carabelli tubercles (Table 1). We identified moderate-to-well developed elevated landmarks on the lingual aspect of the upper molars which showed clear semilunar and distinct demarcations with their surroundings as Carabelli tubercles (Kikuchi, 1986). The distribution and frequency of Carabelli tubercles were calculated, differences in the incidence of Carabelli tubercles between the two groups were compared.

Results

Carabelli tubercles occurred on molars of both groups

In the Japanese group of 240 samples from 124 σ (51.7%) and 116 ϕ (48.3%), Carabelli tubercles were observed in the upper molar region (first molar (6) and second molar (7)) in 38 σ (30.6%), 22 ϕ (19.0%) and a total of 60 individual (25.0%). In the Chinese group, which consisted of 160 samples composed of 74 σ (46.3%) and 86 ϕ (53.7%), the tubercles were observed in molar region (either on the 6 or 7) in 22 σ (29.7%) and 12 ϕ (13.9%) totally of 34 individuals (21.3%; Tables 1 and 2). Examination of the affected samples from Japanese and Chinese revealed Carabelli tubercles on 6 regions in 32 σ (25.8%) and 22 ϕ (18.9%) in the Japanese group, and 21 σ (28.4%) and 12 ϕ (13.9%) in the Chinese group (Table 2).

Analysis of the preferential site of the Carabelli tubercle in Japanese showed it to be present in 45 (18.7%) upper right first molars (6), 51 (21.3%) upper left molars (6), 5 (2.1%) upper right second molars (7) and 5 (2.1%) upper left second molars (7), whereas only 31 (19.4%) 6, 32 (20.0%) 6 and only 1 (0.6%) 7 of Chinese were affected by Carabelli tubercles (Table 3). We also found that the incidence of Carabelli tubercles on 6 or 6 (6) was 90.0% (54 cases) of the affected 60 Japanese, versus, 33 (97.1%) of the 34 affected Chinese showed Carabelli tubercles on either the 6 or 6 (6; Table 2). The present study did not revealed any significant

Table 1. Incidence of the Carabelli tubercle on upper first and second molars in Japanese and Chinese people

	Samples			Samples affected						Samples unaffected					
	σ	ϕ	Total	σ	(%)	ϕ	(%)	Total	(%)	σ	(%)	ϕ	(%)	Total	(%)
Japanese	124	116	240	38	(30.6%)	22	(19.0%)	60	(25.0%)	86	(69.4%)	94	(81.0%)	180	(75.0%)
Chinese	74	86	160	22	(29.7%)	12	(13.9%)	34	(21.3%)	52	(70.3%)	74	(86.0%)	126	(78.7%)
Total			400					94	(23.5%)					306	(76.5%)

Table 2. Incidence of the Carabelli tubercle according to sex

Samples		Sites	♂	♀	Sum
Japanese	124 ♂	<u>6</u> or <u>7</u>	38 (30.6%)	22 (19.0%)	60 (25.0%)
		<u>6</u>	32 (25.8%)	22 (19.0%)	54 (22.5%)
	116 ♀	<u>6</u> & <u>6</u>	25 (20.2%)	14 (12.1%)	39 (16.3%)
Chinese	74 ♂	<u>6</u> or <u>7</u>	22 (29.7%)	12 (13.9%)	34 (21.3%)
		<u>6</u>	21 (28.4%)	12 (13.9%)	33 (20.6%)
	86 ♀	<u>6</u> & <u>6</u>	19 (25.7%)	11 (12.8%)	30 (18.8%)

Table 3. Distribution of Carabelli tubercles on maxillary molars

Group	Japanese (240 samples)		Chinese (160 samples)	
Site	Affected molars	Molars unaffected	Affected molars	Molars unaffected
<u>6</u>	45 (18.7%)	195 (81.3%)	31 (19.4%)	129 (80.6%)
<u>7</u>	5 (2.1%)	235 (97.9%)	0 (0%)	160 (100%)
<u>6</u>	51 (21.3%)	189 (78.7%)	32 (20.0%)	128 (80.0%)
<u>7</u>	5 (2.1%)	235 (97.9%)	1 (0.6%)	159 (99.4%)

differences between the two peoples ($0.05 < P$) in the occurrence of Carabelli tubercles on either the upper first or second molars (6 or 7) or on 6 (Table 2). However, the occurrence of tubercles on 6 or 7 and 6 was to be significantly related to sex in both groups ($0.005 < P < 0.01$; Table 2).

The distribution of unilateral, bilateral and simultaneous occurrence of Carabelli tubercles on 6 and 7 in the 240 and 160 study models of the Japanese and Chinese groups, in particular the relationship to sex, was further examined (Tables 2 and 3). As the data show, 60 Japanese (25.0% of the group) were had Carabelli tubercles either on the first or second molar (6 or 7), and 54 of these persons (22.5%) were affected on 6 regions. In the Chinese group, on the other hand, 34 persons (21.3% of the group) were affected by Carabelli tubercles on either 6 or 7, while 33 subjects (20.6%) were affected on 6. Moreover, bilateral 6 (6| and 6) of 39 (16.3%) Japanese and 30 (18.8%) Chinese, were affected with Carabelli tubercles, and the data indicated that 65.0% of the affected 60 Japanese and 88.2% of the affected 34 Chinese were affected at 6| and 6

simultaneously (Table 2). However, we noted that only one subject (0.4% of 240 individuals) was affected on 7| and 6| bilaterally (not shown in the data). In addition, simultaneous occurrence of Carabelli tubercles was found on both 6| and 7| in 5 individuals in the Japanese group, but there was no simultaneous occurrence of tubercles on 6| and 7| in the present study (not shown in the data).

The data also showed bilateral involvement of the upper first molars in 25♂ (20.2%) and 14♀ (12.1%) Japanese, and 19♂ (25.7%) and 11♀ (12.8%) Chinese. This means that 39 Japanese (16.3% of the entire group and 72.2% of the 54 persons affected by Carabelli tubercles on 6) and 30 Chinese (18.8% of the entire group and 90.1% of the 33 individuals affected by Carabelli tubercles on 6) were found to be affected by Carabelli tubercles bilaterally on both 6| and 6 (Table 2 and Graph 1). As shown in Table 3, we found only one subject (0.6% of 160 individuals examined) with a Carabelli tubercle on the 7|, and no bilateral occurrence on upper second molars was found in the Chinese group. Therefore, the bilateral occurrence of Carabelli tubercles on 6| and 6 was

Graph 1. Incidence of Carabelli tubercles on upper first molars of Japanese and Chinese adults

(̄: unaffected cases; Bi: bilaterally affected; Uni: unilaterally affected)

a significant observation in both the Japanese and Chinese groups in the present study ($p < 0.05$ and $p < 0.01$, respectively). We also noted significant differences between the unilateral and bilateral occurrence of Carabelli tubercles on the upper second molars ($p < 0.05$) in the Japanese, with the tubercles usually occurring unilaterally (Table 3).

Relationship between the occurrence of Carabelli tubercles and body height

The distribution of the body height according to the occurrence of Carabelli tubercles was assessed. The results showed that Carabelli tubercles on upper first molars were most frequent being present in the 166~175-cm body height group of both the Japanese and Chinese groups, 35.0% and 28.6%, respectively, of the groups. Subsequently, data related to body

height was computerized and presented schematically in a graph (Table 3 and Graph 2). A significant difference ($p < 0.05$) in the incidence of Carabelli tubercles was found between 156~165 cm (20.0% and 11.6%, respectively) and 166~175 cm (35.7% and 28.6%, respectively) body height groups of both the Japanese and the Chinese population. The data seemed to indicate a tendency for the occurrence of Carabelli tubercles to be more frequent in taller individuals, but the frequency of occurrence did not significantly differ according to body height ($0.05 < p$).

Discussion

The incidence of Carabelli tubercles in the Japanese group was found to be 23.8% in the upper molar

Table 4. The incidence of Carabelli tubercles on the upper first molar according to sex and body height

Body height	Japanese (♂/♀)			Chinese (♂/♀)		
	Samples	Yes	No	Samples	Yes	No
Under 145 cm	1 (0.4%)	0/0 (0%)	0/1 (100%)	—	—	—
145~155 cm	42 (17.5%)	0/10 (23.8%)	0/32 (76.2%)	10 (6.25%)	0/2 (20.0%)	0/8 (80.0%)
156~165 cm	80 (33.3%)	4/12 (20.0%)	9/55 (80.0%)	69 (43.1%)	1/8 (11.6%)	7/53 (88.4%)
166~175 cm	84 (35.0%)	22/0 (35.7%)	59/3 (64.3%)	63 (39.3%)	16/12 (28.6%)	32/13 (71.4%)
Over 176 cm	33 (13.8%)	6/0 (24.2%)	24/3 (75.8%)	18 (11.3%)	4/0 (22.2%)	14/0 (77.8%)

(♂/♀ = males/females: incidence according to sex)

Graph 2. Relationships between the incidence of Carabelli tubercles on upper first molars, body height and sex

regions, specifically 22.9% on the upper first molars; results similar to those reported in previous studies on Japanese (Ma, 1949; Shikai, 1957; Tsuji, 1958; Sumiya, 1959; Yamada *et al.*, 1960; Sakai, 1974; Kikuchi, 1986). Tubercles on upper first molars were observed in 25.8% of the Japanese males and 18.9% of the females versus 28.4% of the Chinese males and 13.9% the females. In our study, we found that 21.3% of the Chinese individuals had Carabelli tubercles, a higher rate than in previous studies on Chinese populations (Maruyama, 1933; Oshima, 1937).

The present results suggested significant sex differences in both Japanese and Chinese ($p < 0.05$): Carabelli tubercles occurred more frequently in the males. In contrast, the occurrence of Carabelli tubercles according to body height showed a significant difference between the 156–165 cm and 166–175 cm groups ($p < 0.05$) in both the Japanese and Chinese groups.

Assessment of the frequency of unilateral and bilateral occurrence of Carabelli tubercles on the upper molars in the present study showed that bilateral tubercles were significantly more common found on the upper first molars ($p < 0.01$). While there is a study in the literature indicating that tubercles also frequently occur bilaterally on upper second molars, that was not corroborated in the present study (Maruyama, 1933). We observed only one Japanese subject with bilateral occurrence of Carabelli tubercles on the upper second molars, and only one individual was affected unilaterally with Carabelli tubercles in the Chinese group. No significant differences between the incidence of Carabelli tubercles on upper second molars were found within the two groups, however, the data indicated the Carabelli tubercles are more frequent in males, and always occur unilaterally ($p < 0.05$).

Based on correlations between the frequency of the Carabelli tubercle, unilateral and bilateral occur-

rence of the tubercles and regressive tendency of the molars, we postulated that the Carabelli tubercle was originally an inherited character in the molar region, but it shifted to a unilateral character during regression of the maxillary dentition.

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