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CORONO-RADICULAR GROOVES IN A LARGE SAMPLE OF HUMAN MAXILLARY INCISORS

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ABSTRACT Corono-radicular grooves (CRGs) are developmental anomalies on maxillary incisor teeth that have both anthropological and clinical significance. Their reported prevalence varies from around 2% in modern Caucasoid populations to 18% in Chinese, although methods of classification have differed between studies. The aim of this study was to determine the frequency of occurrence and configuration of these grooves in a large sample of Caucasoid extracted permanent maxillary incisors collected in South Australia during the early 1900s (The Ramsey Smith Collection). A total of 1481 permanent maxillary incisors was examined using a dissecting microscope and classified according to tooth type and side. CRGs were scored according to their location, length, and depth. They were observed in 78 teeth (5.3%), with three teeth displaying two grooves. No significant difference in frequency occurred between central (4.7%) and lateral (5.7%) incisors, nor between right and left sides. Most of the CRGs (51.8%) were located in the mid-palatal region of tooth crowns, originating from the cingulum and terminating on the root surface less than 5.0 mm from the cemento-enamel junction (CEJ). All CRGs were less than 1.0 mm in depth. A higher proportion of CRGs was observed on the distal surface of lateral incisors (28.6%) than central incisors (9.4%). The frequency of occurrence of CRGs recorded in this study was higher than that of some previous reports, although the possibility of sampling bias in collections of extracted teeth needs to be taken into account. The relatively high frequency of CRGs on the distal surface of maxillary lateral incisors has important clinical implications, as plaque accumulation and loss of gingival attachment in this region may lead to severe localized periodontal involvement.

INTRODUCTION

Corono-radicular grooves (CRGs) are developmental anomalies that begin on the crown of the tooth and terminate on the root surface at various distances from the cemento-enamel junction (CEJ). They differ from coronal grooves, whose origin and termination points lie entirely on the crown, and from radicular grooves, that are evident on the root only. These grooves probably form by a minor infolding of the enamel organ and Hertwig's epithelial root sheath (Lee et al., 1968), similar to the development of *dens invaginatus*.

Both anthropologists and clinicians have provided descriptions of developmental grooves in the cingulum region of incisor teeth that may continue along the root. Anthropological studies have tended to focus on the condition of the visible dental crown, given that observations are usually made on skeletal specimens in which the examination of the teeth outside of the alveolus may be difficult, or on dental models of

TABLE 1. Parameters for scoring the configuration of corono-radicular grooves adapted from Kogan (1986).

Location of the groove (on the lingual surface)	mesial midpalatal distal
Point of origin	lingual fossa cingulum
Termination point (mm from the cemento-enamel junction)	0.1-4.9 5.0-9.9 ≥10.0
Minimum depth (mm)	<1.0 ≥1.0
Groove form	open closed

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Fig 1. A midpalatal CRG on a maxillary right central incisor. The CRG originates in the lingual fossa and terminates 4.7 mm beyond the CEJ.

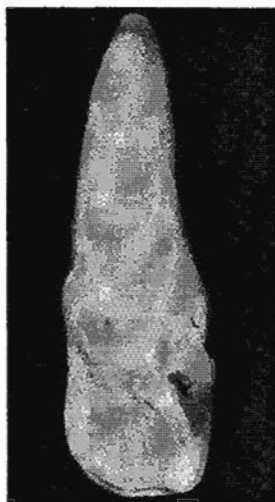


Fig. 2. A mesially located CRG on a maxillary left central incisor. The CRG originates in the lingual fossa and terminates 8.0 mm beyond the CEJ.



Fig. 3. A midpalatal CRG on a maxillary left lateral incisor. The CRG originates on the cingulum and terminates 4.6 mm beyond the CEJ.

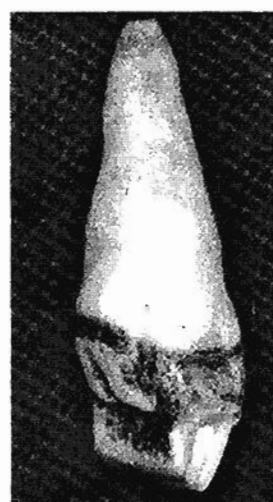


Fig. 4. A mesially located CRG on a maxillary left central incisor. The CRG originates on the cingulum and terminates 6.8 mm beyond the CEJ.



Fig 5. A distally located CRG on an upper left lateral incisor. The CRG originates in the lingual fossa and terminates 6.0 mm beyond the CEJ.

living populations. On the other hand, clinical investigations often include relatively more detailed descriptions of both coronal and radicular features due to their possible association with dental disease.

Campbell (1925) in his study of the dentition and palate of Australian Aborigines noted that a moderate amount of grooving could be seen passing over the cingulum region of maxillary incisor teeth but that the grooves were rarely deepened into marked fissures. Pedersen (1949) also illustrated grooving on the cingulum region of Eskimo maxillary incisors. Lukacs (1988) reported that 51% of maxillary lateral incisors from Neolithic Mehrgarh in Pakistan displayed "interruption grooves" but none were formed on central incisors. More recently, Turner et al. (1991) have described a scoring system for interruption grooves based on their location that was proposed initially by Turner (1967).

Pritchard (1965) was the first clinician to note that lingual grooves on maxillary incisor teeth could predispose individuals to severe localized periodontal destruction. Since then, a variety of names has been used to describe CRGs, including: palato-gingival (Lee et al., 1968; Withers et al., 1981), palato-radicular or palatal-radicular (Kogon, 1986; Mayne and Martin, 1990; Hou and Tsai, 1993), and disto-lingual (Everett and Kramer, 1972).

Reports indicate that CRGs are found usually on the lingual surfaces of maxillary incisors and occur more frequently in lateral incisors than in central incisors (Lee et al., 1968; Withers et al., 1981; Kogon, 1986; Bacic et al., 1990; Hou and Tsai, 1993). CRGs may occur occasionally on the labial surface of the crown, and more than one groove may be found on a single tooth. The presence of a CRG may also be associated with displacement of the CEJ (Kovacs, 1971). Associations have been reported between CRGs and periodontal pocket depth, plaque index, and gingival index (Withers et al., 1981; Bacic et al., 1990; Hou and Tsai, 1993).

Several papers, including that of Walker and Glyn Jones (1983), have reported an association between CRGs and inflammation of the dental pulp possibly resulting from lateral connections between the CRG and the radicular pulp canal. The difficulties associated with successful root canal treatment of teeth with CRGs have also been highlighted (Greenfield and Cambruzzi, 1986).

Although several scoring systems have been used to describe the configuration of CRGs (Kogon, 1986; Bacic et al., 1990; Turner et al., 1991; Hou and Tsai, 1993), none has provided a comprehensive description of the trait. The aim of this study was to determine the prevalence and configuration of CRGs in a large collection of Caucasoid dried extracted maxillary incisors and to compare our results with published data.

MATERIALS AND METHODS

A total of 1481 permanent maxillary incisors obtained from a large collection of Caucasoid dried extracted teeth (the Ramsey Smith Collection, gathered in South Australia during the early 1900s) were examined by one of us (SR).

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The maxillary incisors were categorized as either central or lateral using the criteria proposed by Jordan and Abrams (1992).

With the use of a dissecting microscope the teeth were classified as showing a CRG or not. The configuration of the CRGs, all of which occurred on the lingual surface, was then recorded with a modified form of Kogon's (1986) scoring system (Table 1) using a stereo light microscope and digital calipers.

The location of the groove on the lingual surface was identified as being in the mesial, midpalatal, or distal third of the crown. CRGs were recorded as originating either in the lingual fossa or on the cingulum. The point of termination was recorded as the distance (measured to the nearest 0.1 mm) from the CEJ to the termination of the CRG on the root surface. Depth was judged to be shallow (<1.0 mm) or deep (≥1.0 mm), and grooves were assessed as being open or closed tubes.

Examiner reliability was determined by re-scoring 10.0% of the entire sample, and also by scoring all teeth recorded as displaying CRGs a second time. The percentage concordances for repeated scoring were then determined. Concordance for identification of teeth as non-grooved was 98.6%, and for grooved was 96.3%. For CRG location the concordance was found to be 95.1%, while concordances for the point of origin and the point of termination were 84.1% and 86.4%, respectively.

Chi-square analyses were used to compare frequencies of occurrence of CRGs between right and left sides, and between central and lateral incisors. Associations between CRG location and tooth type were also tested using chi-square analysis. Average lengths of CRGs were compared between central and lateral incisors using a t-test. Statistical significance was set at the 5% probability level.

RESULTS

CRGs were observed in 78 of the 1481 teeth (5.3%). Three of these teeth had two grooves each, giving a total of 81 grooves. Figures 1-5 provide examples of the different types of expression of CRGs observed. The sample also included 23 teeth with coronal grooves terminating at the CEJ and five teeth with radicular grooves originating from the CEJ. These were not included in the analysis as they did not represent true CRGs. Displacement of the CEJ associated with a CRG was observed occasionally.

The distribution of CRGs amongst the four groups of incisors is shown in Table 2. No significant differences in frequencies of CRGs were noted between

TABLE 2. Frequency and distribution of corono-radicular grooves.

Tooth	Number of teeth examined (N)	Number of teeth without grooves (n)		Number of teeth with grooves (n)	
		n	%	n	%
12	398	379	95.2	19	4.8
11	294	279	94.9	15	5.1
21	348	331	95.7	15	4.3
22	443	414	93.5	29	6.5
Sum	1481	1403	94.7	78	5.3

12 is maxillary right lateral incisor. 11 is maxillary right central incisor. 21 is maxillary left central incisor. 22 is maxillary left lateral incisor

TABLE 3. The number (n) and percentage (%) of corono-radicular grooves in each category.

Category	Parameter	n	%
Location of CRGs	Mesial	22	27.2
	Midpalatal	42	51.8
	Distal	17	21.0
Origin of CRGs	Lingual fossa	29	35.8
	Cingulum	52	64.2
Termination point (mm from CEJ)	0.1-4.9	58	71.6
	5.0-9.9	23	28.4
	≥10.0	0	0.0

TABLE 4. Means, standard deviations (SD), and ranges of the lengths of corono-radicular grooves from the cemento-enamel junction to the point of termination on the root surface (mm).

Tooth	$\bar{x} \pm SD$ (mm)	Range (mm)
12	3.7 ± 1.96	0.7-7.6
11	4.2 ± 2.13	0.8-9.3
21	4.2 ± 2.30	0.3-8.0
22	3.8 ± 2.17	0.7-8.5

Abbreviations are the same as those in Table 2.

right and left central incisors (5.1% vs 4.3%), right and left lateral incisors (4.8% vs 6.5%), or lateral and central incisors (5.7% vs 4.7%). Most of the CRGs (51.8%) were located in the mid-palatal region of tooth crowns, with most (64.2%) originating on the cingulum and most (71.6%) terminating on the root surface less than 5 mm from the CEJ (Table 3).

A statistically significant association was found between CRG location mesiodistally and tooth type ($p < 0.05$). A higher frequency of CRGs was observed in the distal region of the lingual surface of lateral incisors compared with central incisors (28.6% vs 9.4%), whereas a higher frequency of mesially located CRGs was observed in central incisors compared with lateral incisors (40.1% vs 18.4%).

The average length of CRGs from the CEJ was 4.1 mm (range 0.3 - 9.3 mm) with no significant difference between central and lateral incisors (Table 4). The depth of all CRGs was less than 1.0 mm. No closed tube CRGs were found.

DISCUSSION

The CRGs could be scored with high reliability on two separate occasions. However, differences were encountered in some instances when CRG expression was faint or in cases for which establishing origins and terminations (including CRGs originating midway between the cingulum or lingual fossa region and CRGs located at the mesial or distal borders of the cingulum) was difficult.

The presence of CRGs in modern populations has been reported to vary from 1.9% in Americans (Everett and Kramer, 1972) to 18.1% in Chinese (Hou and Tsai, 1993). Brabant (1971) reported the prevalence of CRGs to be 12% to 21% in a sample of maxillary incisors from the Megalithic period.

The observed prevalence of true CRGs in our study (5.3%) was higher than most previous findings in modern populations. Our results are, however, in agreement with previous studies (Withers et al., 1981; Kogon, 1986; Bacic et al., 1990; Hou and Tsai, 1993) that have noted a higher prevalence of CRGs in maxillary lateral incisors than in central incisors. The findings may reflect real differences in frequencies between different human populations. However, consideration of other factors that may account for the differences is important. Examples of such factors are sampling bias associated with scoring extracted teeth compared with direct intra-oral assessment, use of models or skeletal material, difficulty in observing faint CRGs, and variations in scoring methods between studies.

Scott and Turner (1997) have reported world variation in the occurrence of interruption grooves in maxillary lateral incisors. They comment on the paucity of comparative data available, noting low frequencies (10-20%) in Sub-Saharan African and Sahul-Pacific groups, intermediate frequencies (20-40%) in Western Eurasia and Sunda-Pacific groups, and high frequencies in Sino-Americans (45-65%). The estimated frequencies of CRGs in our sample of Caucasoid teeth are much lower than those of Scott and Turner, most probably because of differences in the scoring systems used. The classification system of Turner et al. (1991) may include interruption grooves that do not extend down the root, whereas we only scored true CRGs, i.e., those that began on the crown and terminated on the root at various distances from the CEJ. For this reason establishment of the precise basis for scoring grooves on incisor teeth before attempting to make comparisons of frequencies between different groups is important.

CRGs form a potential site for accumulation of dental plaque that is inaccessible to self-care. This favors the development of localized inflammation of gingiva and loss of the attachment of the periodontal ligament. However, not all grooves will cause periodontal breakdown (Withers et al., 1981; Kogon, 1986).

CRGs may also provide the dentist with diagnostic and treatment difficulties (August, 1978). Symptoms of irreversible inflammation of the dental pulp in seemingly healthy teeth may relate to the presence of deep CRGs and movement of bacterial products through small lateral canals (Walker and Glyn Jones, 1983). Deep CRGs or associated CEJ displacement may also create restorative problems for the dentist.

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DENTAL ANTHROPOLOGY OF THE NEOLITHIC RUSSIAN FAR EAST: I EURASIAN RUSSIA

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ABSTRACT Dental morphological trait frequencies of Neolithic Russian Far East burials are more similar to those of Neolithic Central and Western Siberia than to percentages found in contemporaneous European Russians and Ukrainians. Yet, archaeological evidence fails to indicate a close relationship between the Neolithic Russian Far East and Central and Western Siberia cultures. The Neolithic Far East sample is also dentally and culturally more like coastal prehistoric burials and present-day Eskimo and Chukchi samples from Chukotka than like non-coastal peoples of the Russian Far East.

INTRODUCTION

The oldest Russian Far East human remains found to date have been excavated from typologically Neolithic burials at Boisman 2, which is located south of Vladivostok (Fig. 1).



Fig. 1. Map showing the locations of Boisman 2 and the other Neolithic sites discussed in the text.