

# Frequency of Three-Rooted Mandibular Permanent Molars in Anatolia from the Middle Ages to the Present

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Alındı/Received: 20 Eylül / September 2018

Düzeltildi/Revised: 12 Aralık / December 2018

Kabul/Accepted: 27 Aralık / December 2018

Erken Görünüm/Early View: 11 Ocak / January 2019

Yayınlanma/Published: 12 Haziran / June 2019

## Orta Çağ'dan Günümüze Anadolu'da Üç Köklü Mandibular Daimi Molar Dişlerin Görülme Sıklıkları

### Abstract

Teeth are among the structures of the skeleton which are most resistant against external effects. It has also been put forth in population, family and twin studies examining the impacts of genes and the environment that tooth development is generally affected less from environmental factors and that it has a significant genetic component. It is possible to understand the biocultural kindredship relations, oral health, relationship between oral health and life style and nutritional habits by taking metric measurements from tooth, examining pathologic formations or variations. In our study, three-rooted mandibular permanent molars have been examined from among the root variations in teeth and it has been examined whether there has been any change in Anatolia from the past to the present. Three different populations were examined in our study; two of which were from the Medieval Period and one was current population. It is known that teeth variations differ geographically and that three-rooted mandibular permanent molars are of Asiatic origin. Whereas three-root was not observed in the first molar teeth in our current population, it was observed that the ratio of three-root in the second molar teeth declined significantly from the past to the present. It has been determined in studies carried out on different populations in Turkey that no significant changes have been observed between Anatolian populations of the past and today's populations and that the ratios are close to each other.

**Key Words:** Nonmetric traits, dental, three-rooted mandibular molars

### Introduction

Variations are termed in normal skeleton anatomy as anomalies and are expressed as normal diversity instead of pathological or traumatic. Variations are generally defined visually and the presence or absence of various characteristics (Saunders, 1989). A total of more than 200 characteristics have been determined for the skull, teeth and body skeleton (Ossenberg, 1976). These are variations related with the number of bones or teeth, presence, absence or number of foramen or sulcus on the bone, tooth crown variations, root variations, fracture union anomalies, articular surface variations

### Öz

Dişler iskeletin dış etkilere en dayanıklı yapılarındandır. Genlerin ve çevrenin etkilerinin araştırıldığı popülasyon, aile ve ikiz çalışmalarında da diş gelişiminin genellikle çevresel faktörlerden daha az etkilendiği ve önemli bir genetik bileşene sahip olduğu ortaya konmuştur. Biyokültürel akrabalık ilişkilerini, ağız sağlığını, ağız sağlığı ile yaşam biçimi ve beslenme alışkanlıkları arasındaki ilişkileri; ele geçen dişlerden metrik ölçümler alarak, patolojik oluşumları ya da varyasyonları inceleyerek anlamak mümkündür. Araştırmamızda dişlerde kök varyasyonlarından üç köklü mandibular molar dişler incelenmiş, Anadolu'da geçmişten günümüze bir değişimin olup olmadığına bakılmıştır. Çalışmamızda Ortaçağ'dan iki ve günümüzden bir olmak üzere üç ayrı topluluk incelenmiştir. Diş varyasyonlarının coğrafi farklılık gösterdiği ve üç köklü mandibular molar dişlerin Asyatik kökenli olduğu bilinmektedir. Çalışmanın sonuçlarına göre günümüz toplumunda birinci molar dişlerde üç köke rastlanmazken ikinci molar dişlerde üç kök oranının geçmişten günümüze büyük oranda düşüş gösterdiği görülmüştür. Türkiye'de daha önce yapılmış farklı topluluklara ait çalışmalarda ise eski Anadolu toplumları ile günümüz toplumları arasında önemli bir değişim gözlenmediği, oranların birbirine yakın olduğu belirlenmiştir.

**Anahtar Sözcükler:** Ölçülemeyen özellikler, diş, üç köklü mandibular molarlar

and variations caused by regional bone growth and insufficient regional ossification.

Dental anatomists and anthropologists in the 19<sup>th</sup> century have defined morphologic variations and have commented on their relative frequencies in different racial populations (Scott and Turner, 2008). Many dental nonmetric traits have been defined in the last century and many researches have discussed their functional and phylogenetic importance (Matsumura and Hudson, 2005). Even though human teeth seem fundamentally the same, there are various morphological differences both in and out of the population. Indeed, significant

geographical variations have been determined in both teeth morphology and tooth size in many populations (Scott and Turner, 1988).

Contrary to the cranial nonmetric traits, many studies have been carried out on twins (Wood and Green, 1969; Biggerstaff, 1970; Corruccini et al., 1986) and families (Lee and Goose, 1972; Harris and Bailit, 1980; Nichol, 1989) regarding the inheritance of dental nonmetric traits. It is indicated that dental development and especially dental morphology is generally controlled by a strong inheritance (Hillson, 2005). In addition, it has been put forth in many family and twin studies carried out for examining the impacts of genes and the environment that dental development is generally affected less from environmental factors and that there is a significant genetic component (Sofaer *et al.*, 1972; Hillson, 2005). Even though it is known that using tooth variations in biological distance studies is more reliable since it is in close resemblance with data acquired from mtDNA and other genetic identifiers (Hillson, 2005), the facts that these variations are not related with gender and age, that there is no standard recording system, that the tooth enamel as the strongest part of the body is protected better than bones and that they do not change significantly during the post-mortem period, make it more advantageous to use dental non-metric traits in both fractured bones and small sample sizes.

Three-rooted mandibular permanent molars teeth were first defined in 1844 by Carabelli and are of great importance for defining the origins of populations (Carabelli, 1844). Mandibular permanent molars are generally two-rooted mesiodistally. While single-root is quite rare, three-rooted mandibular molars are more common. The third root is frequently in the distolingual direction but only Sperber and Moreau (1998) have reported the existence of a third root in the distobuccal direction. This variation is observed more frequently in Mongoloids including the natives of Malaya, China, Japan, America and Canada while it is less frequent in European populations including British, German, Dutch, Fin as well as African populations including Caucasians and Bantu, Senegal and Bushmen (Younes et al., 1990; Rashid and Suliman, 2006; Shahi *et al.*, 2008; Garg *et al.*, 2010; Kim *et al.*, 2013). Literature records are generally comprised of clinical studies on modern populations, while the number of studies on skeletal material in ancient populations is less.

Anatolia has a strategic importance since it is the connection between Asia, Europe and Africa. Anatolia is located on the migratory routes of populations and has hosted many populations for thousands of years

due to its geographical characteristics and its climate which make it easier for human populations to live. Even though the number of studies on the existence of three-rooted mandibular permanent molars teeth in Anatolia is quite rare, they have only been put forth as a numerical ratio. However, our purpose in this study will be to compare ancient Anatolian populations with our current society and to understand whether there are any changes in origin or any differences from the past to the present.

## Materials and Methods

Two different skeleton populations were examined in this study. The first was acquired from Van Castle Mound (VCM) located in Central Van, a province in Eastern Turkey. Van Castle Mound Excavations have been carried out by Istanbul University Faculty of Literature Van Region Historical and Archaeological Research Center Directorate during 1989-1991 under the leadership of Prof. Dr. Taner Tarhan in three periods. The excavations that were started again in 2010 under the leadership of Assoc. Prof. Erkan Konyar are still ongoing. A total of 146 skeletons unearthed during the 1989-1991 excavation season are under protection at Ankara University Faculty of Languages, History and Geography Enver Bostancı and Refakat Çiner Laboratory, whereas the 382 skeletons unearthed during the 2010-2012 excavation season are under protection at the Ahi Evran University Faculty of Science-Literature Paleoanthropology Department Laboratory. The second series is comprised of skeleton remains unearthed from the Karagündüz Mound located along the western coast of Lake Erçek 34 km. northeast of Van. Both populations date back to the Middle Age. Karagündüz Middle Age excavations have been carried out by Istanbul University Faculty of Literature Van Region Historical and Archaeological Research Center Directorate during 1994-1999 under the leadership of Prof. Dr. Veli Sevin. A total of 890 skeletons discovered during the excavation period are under protection at the Ankara University Faculty of Languages, History and Geography Enver Bostancı and Refakat Çiner Laboratory. The current population in our study was comprised of archival records of Ankara University Faculty of Dentistry Orthodontics Department and Gazi University Faculty of Dentistry Oral and Maxillofacial Radiology Department. Necessary permission for the research was obtained from Ankara University Ethics Committee.

Panoramic radiographs (a technique in which lower and upper teeth are displayed on a single film

together with mandibles and neighboring anatomic structures (Figure 1) and CR (Computed Radiology) System have been used in our study. CR is a system for transforming from analog to digital image. In short; tapes with phosphor plates inside instead of x-ray tapes are used in this system. Panoramic radiographs are shot on phosphor containing tapes using a classical x-ray device. The radiological image formed on the phosphor plates inside the tapes are uploaded to the computer environment by way of special digital scanners. The images that are transferred to the digital media are examined in the computer environment by reflecting them onto the screen.

A total of 122 individuals comprised of 40 females, 48 males and 34 children were examined from the Van Castle Mound population and a total of 116 individuals comprised of 38 females, 42 males and 36 children were examined from the Karagündüz population. It was observed upon examining the age distributions of the populations studied that the number of children examined from the Van Castle Mound population was 34, the number of early adults was 33, the number of medium adult individuals was 29 and the number of late adult individuals was 25. Whereas the number of children was 36 in the Karagündüz population, the number of early adults was 37, the number of medium adults was 33 and the number of late adults was 10. Primary and secondary mandibular molar teeth were examined for a total of 238 individuals.

Bass (1987), Krogman and İşcan (1986) and Olivier (1969) criteria were taken into consideration when estimating the sex of skeletons; whereas the teeth calcification process was used for the age estimation of babies and children (Ubelaker, 1978) aging from epiphysis (Brothwell, 1981), symphysis pubis (Todd, 1920), auricular surface (Lovejoy *et al.*, 1985) and aging from clavicle, humerus and femur (Kaur and Jit, 1990; Szilvassy and Kritscher, 1990) were used for adults. Mandibular molar characteristic was recorded as present/absent in accordance with the ASUDAS (The Arizona State University Dental Anthropology System) (Turner *et al.*, 1991) standards. Only the teeth on the mandibula were examined macroscopically.

Panoramic radiographies were examined for a total of 669 individuals with 319 males and 350 females from the current series with ages varying between 7-19. The sample group was comprised of 4 individuals aged 7, 15 individuals aged 8, 27 individuals aged 9, 54 individuals aged 10, 82 individuals aged 11, 98 individuals aged 12, 92 individuals aged 13, 92 individuals aged 14, 84 individuals aged 15, 59 individuals aged 16, 48 individuals

aged 17, 10 individuals aged 18, 4 individuals aged 19.

## Results

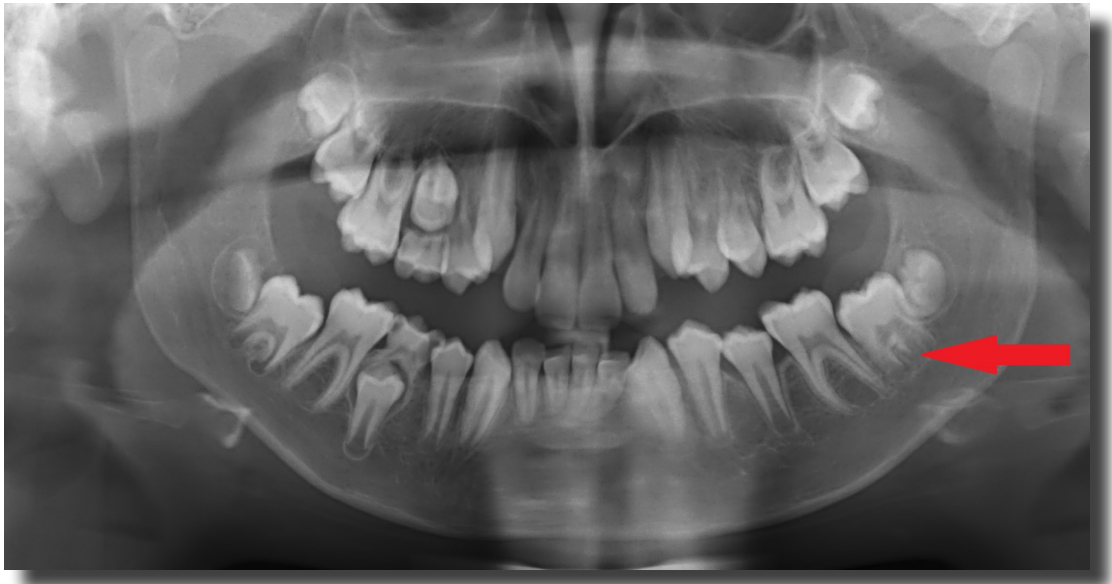
A total of 175 primary molars, 152 secondary molars from the Van Castle Mound were examined in the study. Of these, 85 belong to the left primary molar, 90 to the right primary molar, 73 to the left secondary molar and 79 to the right secondary molar. Whereas a total of 140 primary molars and 116 secondary molars were examined from the Karagündüz population. Of these, 68 belong to the left primary molar, 72 to the right primary molar, 57 to the left secondary molar and 59 to the right secondary molar. A total of 1293 primary molars and 1131 secondary molars were examined from the current series. Of these, 651 belong to the left M1, 642 to the right M1, 561 to the left M2 and 570 to the right M2. The number of mandibular molar teeth examined in the study for 907 individuals was 3007.

According to the results of this study, three-root ratio in mandibular molar teeth for the right and left side data combined was 3,4% for the primary molar teeth in the Van Castle Mound and 4,25% for the Karagündüz population. Three-root ratio in secondary molar teeth was 10,15% for the Van Castle Mound population and 8,59% for the Karagündüz population. While three-root is not observed in the primary molar teeth in the present day, this ratio for secondary molar teeth was 2,28% (Table 1). Three-root ratio is higher for secondary molar teeth in comparison with primary molar teeth.

Majority of the researchers are of the opinion that this is observed mostly on the right side, while there are also many researchers who indicate that it is observed mostly on the left side (Tratman, 1938; Steelman, 1986; Quackenbush, 1986; Loh, 1990; Gulabivala, 2001; Tu *et al.*, 2007). A statistically significant difference was not observed between the right and left side data in this study (Table 2).

## Discussion

Variations studies are of significant importance for understanding the hereditary mechanisms among populations, genetic affinities, and origins of populations, migratory routes and gene flow. Variation studies on the anatomic root numbers and genetic structure of teeth are among the frequently studied topics in many countries from Asia to Europe, Europe to America and America to Oceania. The morphological characteristic of teeth which is part of the biological inheritance is carried over by people during migration (Turner and Scott, 1997). It has been indicated in many studies on this topic that the ratio of the number of roots of teeth



**Figure 1.** Three-rooted second mandibular permanent molars example from the current population

**Table 1.** The frequency of three-rooted mandibular molars according to populations

	Left M1			Right M1			Left M2			Right M2		
	N	n	%	N	n	%	N	n	%	N	n	%
Van Castle Mound	85	1	1,18	90	2	2,22	73	4	5,48	79	4	5,06
Karagündüz	68	1	1,47	72	2	2,78	57	2	3,51	59	3	5,08
Current Study	651	0	0,00	642	0	0,00	561	7	1,25	570	6	1,05

N: Number of teeth examined

n: Number of teeth observed

varies geographically.

Even though the hereditary mechanism for three-rooted permanent mandibular molars is not known in detail, it has been concluded as a result of the studies carried out that recessive or dominant mutation is the cause for this (Taylor, 1899; Tratman, 1938; Turner, 1971; Tu *et al.*, 2007; Drusini and Swindler, 2009). Turner (1971) carried out a study on the locals of America in which it was put forth that the roots of mandibular first molar teeth have a stable characteristics and high genetic component. Whereas Corzon (1974) elaborated on this opinion thus suggesting that three-rooted first molar tooth has a high genetic transition. It can be observed upon examining the worldwide distribution of three-rooted mandibular molar teeth that this variation is of Mongoloid origin; with a rate of 8-21,1% in Chinese, 20% in Japanese, 12,5-19% in Eskimos, 33,1% in Koreans and 11-16% in local Americans, 43,7% in Aleutians (Kim *et al.*, 2013). However, the ratio is much lower in the Caucasus; with 1,35% in Germans, 8,1% in Iraqis, 1,44% in Iranians, 0,65% in Egyptians and 2,33% in Saudis (Younes *et al.*, 1990; Shahi *et al.*,

**Table 2.** Differences in side for the characteristic

	df	$\chi^2$	Sig.
Van Castle Mound	1	30,110	0
Karagündüz	1	82,610	0
Current Study	1	126,770	0

2008; Garg *et al.*, 2010). The maximum percentage in African populations is 3% (Rashid and Suliman, 2006).

Even though the number of studies on Anatolian societies is quite low, two studies are of special importance. One of these is the study by Erkman and Kaya in 2014. They carried out a study in which two different populations at Van Dilkaya in the Early Iron Age and the Medieval Period have been compared. According to the results of the study; while three-roots are not observed in the mandibular permanent molars teeth in the Early Iron Age population, the ratios for three-roots were 1,05% and 0,67% in the first and second molar tooth in the Medieval Period population respectively. It can be observed that these ratios are similar with the results acquired for the Medieval Period



populations in our study. However, it can be observed as a result of the study carried out on current populations by Akpınar *et al.*, in 2004 based on Sivas Cumhuriyet University Faculty of Dentistry archival records that three-roots have been observed at percentages of 3,4% and 3,5% in the first and second molar teeth respectively.

## Conclusions

It is observed that the results of this study do not differ significantly from the current population data of our study. It can be observed when all studies are evaluated as a whole that the ratios of three-rooted mandibular permanent molars have not changed significantly since the Medieval Period. It is estimated that this variation is of Asiatic origin and that it is passed down to Anatolian populations by way of migrations from Asia. The fact that three-rooted mandibular molars teeth are not observed during the Iron Age is an indication that the variation has reached Anatolia as a result of migration waves. It is estimated that the first raids to Anatolia started in the 4<sup>th</sup> century with Turkish raids but that they were not significant enough to result in the genetic structure changes in the region. Giving emphasis to studies carried out on populations living during these time intervals may clarify these estimations. Two large mass migrations have taken place starting from the 11<sup>th</sup> century from the East to Anatolia. The first was the migration wave that took place after the 1071 Battle of Manzikert. While the other was the migration wave that started after 1220 when various Oghuz tribes running away from the Mongols settled down in Anatolia (Şeker, 2002; Kayapınar and Ayönü, 2015). The demographic structure of Anatolia changed almost completely as a result of these migrations. It is possible that three-rooted mandibular permanent molars have started to be observed in Anatolia from these dates onwards. Anatolia has always received migrations due to its location of strategic importance at the intersection of Asia, Europe and Africa continents. Anatolia has continued to receive and give migrations after the great waves of migration during the 11<sup>th</sup>-13<sup>th</sup> centuries.

According to our findings, even though it is not possible to establish certain results about the migration history of Anatolia a general opinion can be given. Similar future studies to be carried out on ancient Anatolian populations will increase our knowledge on the demographic structure of Anatolia from the past to the present, thereby enabling us to acquire more information on the origins of populations, migratory activities, gene flow and genetic affinities.

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