

Application of Odontometric Dimensions of Molars in Sex Assessment in Bulgarians

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Abstract

Introduction: Sex estimation is an important step in developing a biological profile. Teeth are one of the most durable physical elements in the human body and thus can be used very successfully for this purpose. The aim of the present study was to determine sex differences in odontometric dimensions of maxillary and mandibular molars in Bulgarians.

Materials and methods: The study included 232 healthy subjects (121 males, 111 females) of Bulgarian origin in the age group of 20–40 years, with fully erupted, periodontal disease free, caries free, non-worn teeth. Vestibulolingual, mesiodistal and cervicoincisal (coronal height) dimensions of maxillary and mandibular molars were measured by Dentistry Sliding Vernier Caliper, Ridge Mapping Caliper Type A and Type B and analyzed with SPSS 23.0. The level of statistical significance was set at $p < 0.05$.

Results: Cervicoincisal dimensions in both maxillary and mandibular molars, except for the maxillary left second molars, were significantly higher in males compared to females. Similar statistically significant differences were found in mesiodistal dimensions in first molars from both jaws. Vestibulolingual dimensions in both maxillary and mandibular first molars and mandibular second molars were significantly higher in males compared to females as well.

Conclusions: The results of our measurements exhibited statistically significant sex differences in both maxillary and mandibular molars in people of Bulgarian origin. In accordance with similar odontometric studies, molars may successfully differentiate both sexes and thus determine the need for further investigations in this field.

Keywords

Bulgarians, molars, odontometric measurements, sexual dimorphism

INTRODUCTION

Forensic dentistry is a vital branch of forensic sciences, which deals with examination, and evaluation of dental evidences for identification of victims of crime, accidents or calamities. In mass disasters where visual identification of victims is challenging because of the destruction of the

soft tissue, not all bones of an individual are recovered. In such instances, the skull and teeth often provide the identification material.^[1] Teeth are known to be unique organs made of the most enduring mineralized tissues in the human body, characterized by extraordinary resistance of external effects, thus they form an excellent structure for forensic investigations.^[2] Many authors reported the

application of dental features for defining approximate age.^[3] Identification of sex is also important in narrowing down the victim, allowing the exclusion of one-half of the population. This study defines the significance of teeth in sexual dimorphism for the following reason: the pelvic is by far the most precise structural indicator, especially the femur^[4], but may be fragmented; sexual characteristics in the bones of non-adults are not fully developed; DNA analysis can give precise results but it is expensive and time consuming. Numerous studies have found differences between male and female odontometric traits, but the extent of sexual dimorphism in dental size varies from population to population.^[5,6] Many researchers report that molars are among the most dimorphic teeth.^[7] They are the first permanent teeth to erupt in the oral cavity, thus are available for use in sex assessment at an early stage. Incisors and canines are more prone to trauma, developmental anomaly, show crowding, thus odontometric analysis was carried out to assess the reliability of molars in sex assessment.

AIM

The purpose of the study was to determine the sexual dimorphism in odontometric dimensions of maxillary and mandibular molars in Bulgarians.

MATERIALS AND METHODS

The present study included 121 males and 111 females of Bulgarian origin living in Pazardzhik and Plovdiv in the age group 20-40 years. Before starting the study, subjects were informed about the nature of the study and written informed consents were obtained. Patients were included based on the following criteria: presence of complete set of fully erupted and periodontally healthy teeth; presence of non-carious and non-worn teeth; no dental history of any crown restorations or bridges; normal occlusion. Exclusion criteria were history or clinical evidence of cleft palate, orthognathic surgery or trauma, history or clinical features suggestive of endocranial disorders, metabolic disorders, developmental disorders, and history of prolonged illness.

Directly measured parameters

Vestibulolingual, mesiodistal, and cervicoincisal (coronal height) dimensions of molars were measured by Dentistry Sliding Vernier Caliper, Ridge Mapping Caliper Type A and Type B. We used the technique of Martin-Saller, modified by Professor Yordanov.^[8] According to him, the mesiodistal dimension is the greatest mesiodistal distance between the contact points of teeth, and usually it is in the upper or middle third of the coronal height. It is also termed the dental width. The vestibulolingual dimension, also termed as dental thickness, is the greatest dimension between buccal (labial) and lingual surfaces of crown, taken at right

angle to the plane in which mesiodistal diameter is taken. Cervicoincisal (cervicoocclusal) dimension, termed also as the coronal height, is the greatest dimension by vertical axis from the tip of the highest tubercle to the cervical line on the buccal side. For the coronal height of the molars, we used the technique of Zubov, modified by Professor Yordanov, 2012, according to which it is better to measure the height between the occlusal surface (the lowest point between the two vestibular tubercles) and the cervical line, without considering the height of the tubercles.

Statistical analysis

The measurements were analyzed with SPSS 23.0 using Student's t-test. The level of statistical significance was set at $p < 0.05$. The degree of significance was considered weak ($p < 0.05$), moderate ($0.01 > p > 0.001$) or high ($p < 0.001$).

RESULTS

1. We found statistically significant differences between the two sexes in the mesiodistal dimensions of the maxillary first molars with high degree of significance ($p < 0.001$). The mean values in males were higher than in females (**Table 1**).
2. Significant differences were found in the vestibulolingual dimensions of the maxillary first molars, but they were with weak degree of significance ($p < 0.05$). Males show higher values than females. We detected a tendency for higher mean values in males than females in the maxillary second right molars ($p = 0.058$) (**Table 2**).
3. We found statistically significant differences in the coronal height upper first molars and second right molars between the two sexes in favor of males again. The right showed moderate degree of significance ($0.01 > p > 0.001$), while the left showed weak degree of significance ($p < 0.05$). In the maxillary second right molars, the degree of significance was high ($p < 0.001$) (**Table 3**).
4. Statistically significant differences in the mesiodistal dimensions of the mandibular first molars were found between the two sexes in favor of males again. The degree of significance was weak in the right ($p < 0.05$) and moderate in the left ones ($0.01 > p > 0.001$) (**Table 4**).
5. Vestibulolingual dimensions of the mandibular molars showed statistically significant higher values in males compared to females with high degree of significance in the first ($p < 0.001$) and weak in the second ($p < 0.05$) (**Table 5**).
6. Similar statistically significant differences were found in the coronal height of the lower molars in favor of males again. Both left and right molars showed moderate degree of significance ($0.01 > p > 0.001$) (**Table 6**).

Table 1. Comparison between mesiodistal dimensions of maxillary molars in Bulgarian males and females

| Males | | | | | Females | | | | | SD |
|-------|-----|-------|------|------|---------|-----|-------|------|------|--------|
| Tooth | N | Mean | SD | SE | Tooth | N | Mean | SD | SE | P |
| M16MD | 121 | 10.70 | 0.67 | 0.10 | M16MD | 111 | 9.95 | 0.62 | 0.09 | <0.001 |
| M17MD | 121 | 10.00 | 0.53 | 0.08 | M17MD | 111 | 9.56 | 1.48 | 0.23 | 0.070 |
| M26MD | 121 | 10.58 | 0.82 | 0.12 | M26MD | 111 | 10.00 | 0.65 | 0.10 | <0.001 |
| M27MD | 121 | 9.98 | 0.51 | 0.08 | M27MD | 111 | 9.77 | 0.64 | 0.10 | 0.100 |

Table 2. Comparison between vestibulolingual dimensions of maxillary molars in Bulgarian males and females

| Males | | | | | Females | | | | | SD |
|-------|-----|-------|------|------|---------|-----|-------|------|------|-------|
| Tooth | N | Mean | SD | SE | Tooth | N | Mean | SD | SE | P |
| M16VL | 121 | 10.84 | 0.53 | 0.08 | M16VL | 111 | 10.53 | 0.59 | 0.09 | 0.015 |
| M17VL | 121 | 10.47 | 0.55 | 0.08 | M17VL | 111 | 10.23 | 0.57 | 0.09 | 0.058 |
| M26VL | 121 | 10.84 | 0.53 | 0.08 | M26VL | 111 | 10.56 | 0.59 | 0.09 | 0.024 |
| M27VL | 43 | 10.35 | 0.53 | 0.08 | M27VL | 111 | 10.26 | 0.58 | 0.09 | 0.440 |

Table 3. Comparison between coronal height of maxillary molars in Bulgarian males and females

| Males | | | | | Females | | | | | SD |
|-------|-----|------|------|------|---------|-----|------|------|------|--------|
| Tooth | N | Mean | SD | SE | Tooth | N | Mean | SD | SE | P |
| M16H | 121 | 6.19 | 0.55 | 0.08 | M16H | 111 | 5.81 | 0.55 | 0.08 | 0.002 |
| M17H | 121 | 6.12 | 0.50 | 0.08 | M17H | 111 | 5.74 | 0.49 | 0.08 | <0.001 |
| M26H | 121 | 6.16 | 0.75 | 0.11 | M26H | 111 | 5.81 | 0.59 | 0.09 | 0.019 |
| M27H | 121 | 5.95 | 0.62 | 0.09 | M27H | 111 | 5.72 | 0.55 | 0.08 | 0.068 |

Table 4. Comparison between mesiodistal dimensions of mandibular molars in Bulgarian males and females

| Males | | | | | Females | | | | | SD |
|-------|-----|-------|------|------|---------|-----|-------|------|------|-------|
| Tooth | N | Mean | SD | SE | Tooth | N | Mean | SD | SE | P |
| M36MD | 121 | 10.79 | 0.56 | 0.09 | M36MD | 111 | 10.42 | 0.85 | 0.13 | 0.019 |
| M37MD | 121 | 10.05 | 0.62 | 0.09 | M37MD | 111 | 10.02 | 0.56 | 0.08 | 0.855 |
| M46MD | 121 | 10.77 | 0.57 | 0.09 | M46MD | 111 | 10.36 | 0.76 | 0.12 | 0.006 |
| M47MD | 121 | 10.07 | 0.46 | 0.07 | M47MD | 111 | 10.00 | 0.53 | 0.08 | 0.517 |

Table 5. Comparison between vestibulolingual dimensions of mandibular molars in Bulgarian males and females

| Males | | | | | Females | | | | | SD |
|-------|-----|-------|------|------|---------|-----|-------|------|------|--------|
| Tooth | N | Mean | SD | SE | Tooth | N | Mean | SD | SE | P |
| M36VL | 121 | 10.65 | 0.72 | 0.11 | M36VL | 111 | 10.05 | 0.53 | 0.08 | <0.001 |
| M37VL | 121 | 10.28 | 0.59 | 0.09 | M37VL | 111 | 9.98 | 0.46 | 0.07 | 0.010 |
| M46VL | 121 | 10.67 | 0.68 | 0.10 | M46VL | 111 | 10.05 | 0.49 | 0.08 | <0.001 |
| M47VL | 121 | 10.26 | 0.54 | 0.08 | M47VL | 111 | 10.00 | 0.49 | 0.07 | 0.023 |

Table 6. Comparison between coronal height of mandibular molars in Bulgarian males and females

| Males | | | | | Females | | | | | SD |
|-------|-----|------|------|------|---------|-----|------|------|------|-------|
| Tooth | N | Mean | SD | SE | Tooth | N | Mean | SD | SE | P |
| M36H | 121 | 6.28 | 0.63 | 0.10 | M36H | 111 | 5.91 | 0.53 | 0.08 | 0.004 |
| M37H | 121 | 6.19 | 0.59 | 0.09 | M37H | 111 | 5.84 | 0.53 | 0.08 | 0.005 |
| M46H | 121 | 6.23 | 0.61 | 0.09 | M46H | 111 | 5.83 | 0.58 | 0.09 | 0.003 |
| M47H | 121 | 6.12 | 0.63 | 0.10 | M47H | 111 | 5.72 | 0.59 | 0.09 | 0.003 |

DISCUSSION

Our results showed sexual dimorphism in all of the dimensions of the first molars and in some of them of the second ones. The mean values were statistically higher in males than in females. They are consistent with the results found by Ditch and Rose^[9] who were the first to prove that teeth could be used successfully for determining sex. Other authors confirmed these results (Iscan and Kedici^[10], Pettenati-Soubayroux^[11]). We found statistically significant differences in the coronal height of both first and second molars in favor of males which is probably related with the fact that males have larger cranial sizes and more specifically lower third of the face.^[12] Avinash Tejasvi measured the circumference of the cranium in Indians and also proved larger cranial sizes in males compared to women.^[13] Differences in the coronal height of maxillary teeth proving sexual dimorphism in favor of males were described by Bhuvan Nagpal^[14] and Lakhanpal^[15]. Garn proposed a formula for calculating the percentage of sexual dimorphism:

$$[(X_m/X_f)-1] \times 100$$

where X_m is the mean value of the dental size in males and X_f - in females.^[16]

In the present study, we found statistically significant differences also in the mesiodistal and vestibulolingual dimensions of the upper and lower first molars. There were no statistically significant differences in the mesiodistal dimensions of the second molars while in the vestibulolingual dimensions there were statistically significant differences in the lower ones and only a tendency in the upper right ones. The mean values in males were again higher compared to females. The reasons for the bigger odontometric dimensions in male molars are probably the differences in the differentiation of the dentition in males and females. According to Schwartz and Dean^[17], the concentration of sexual hormones during the development of the tooth germ is related with that. The differences in the odontometric dimensions between the sexes is due to the thickness of the tooth dentin which is more in males because the mitotic cellular activity in the dental epithelium and papilla are influenced by the Y-chromosome. This chromosome induces genesis of dentin that defines the size of the enamel-dentinal junction. These findings are in accordance with the results of Smith^[18] and Saunders^[19] who claimed that there was larger dentinal zone in males that leads to greater odontometric dimensions in the male maxillary teeth.

Our results show that the mesiodistal dimensions of the maxillary first molars have the highest degree of sexual dimorphism (7.54%) with statistical significance of high level ($p < 0.001$), followed by the coronal height of the maxillary second molars (6.62%), maxillary first molars (6.62%), mandibular first molars (6.26%), and mandibular second molars (5.99%). The least sexual dimorphism was found in vestibulolingual dimensions of mandibular first molars (5.97%). This is in accordance with the studies by various

researchers.^[20,21] Other authors found that vestibulolingual dimensions of maxillary first molars showed the highest level of sexual dimorphism.^[22] Kazzazi et al. reported that the most sexually dimorphic measurement was the mesiodistal diameter of the maxillary second molars.^[23] This variation in the magnitude of dimorphism can be a result of environmental influences on tooth size such as variation in food resources, others have suggested the interference of cultural factors with biological forces.^[24]

The present study showed bilateral asymmetry only in the coronal height of the maxillary second molars. No significant differences were found in the other dimensions between left and right molars, indicating almost symmetric dimensions. This finding is in agreement with studies done by Preeti et al.^[25] and Rai et al.^[26] that showed no tendency for the dental dimensions on one side to be consistently larger than on the other side.

The fact that in different populations different maxillary teeth show sexual dimorphism proves that the odontometric dimensions are population specific, which defines the need of data for each population. Since there are currently very few studies of sex estimation using odontometric data in Bulgarians, the present study makes a significant contribution to the development of the standards of sex assessment in this population.

In some studies, mesiodistal dimensions show higher degree of sexual dimorphism, in others vestibulolingual dimensions show higher degree of sexual dimorphism. For these reasons, it is recommended that we should measure all odontometric dimensions.

CONCLUSIONS

Sexual dimorphism in tooth size and the accuracy of odontometric sex prediction is found to vary in different population, and therefore, it is necessary to determine specific population values in order to make identification possible. The present study revealed the existence of sex differences in the mesiodistal, vestibulolingual dimensions and coronal height of first molars and vestibulolingual dimensions and coronal height of second molars in Bulgarians. Our results showed that mesiodistal dimensions of maxillary first molars exhibited the greatest sexual dimorphism. In accordance with similar odontometric studies, teeth may successfully differentiate both sexes and thus determine the need for further investigations in this field.

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Применение одонтометрических размеров моляров при оценке пола у болгар

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Резюме

Введение: Оценка пола является важным шагом в разработке биологического профиля. Зубы являются одним из самых прочных физических элементов человеческого тела и поэтому могут очень успешно использоваться для этой цели. Цель настоящего исследования состояла в том, чтобы определить половые различия в одонтометрических размерах верхних и нижних моляров у болгар.

Материалы и методы: В исследование были включены 232 здоровых человека (121 мужчина, 111 женщин) болгарского происхождения в возрастной группе 20–40 лет, с полностью прорезавшимися, свободными от пародонтита, кариеса, нестёртыми зубами. Вестибулолингвальный, мезиодистальный и цервикоинцизальный (коронковая высота) размеры моляров верхней и нижней челюсти измеряли с помощью стоматологического раздвижного верньерного штангенциркуля (Dentistry Sliding Vernier Caliper), штангенциркуля для измерения толщины костного гребня (Ridge Mapping Caliper) типа А и типа В и анализировали с помощью SPSS 23.0. Уровень статистической значимости был установлен на уровне $p < 0.05$.

Результаты: Пришеечно-резцовые размеры моляров верхней и нижней челюсти, за исключением левого второго моляра верхней челюсти, были значительно выше у мужчин по сравнению с женщинами. Аналогичные статистически значимые различия были обнаружены в мезио-дистальных размерах первых моляров обеих челюстей. Вестибулолингвальные размеры первых моляров верхней и нижней челюсти, а также вторых моляров нижней челюсти были значительно выше у мужчин по сравнению с женщинами.

Заключение: Результаты наших измерений показали статистически значимые половые различия в молярах верхней и нижней челюсти у лиц болгарского происхождения. В соответствии с аналогичными одонтометрическими исследованиями моляры могут успешно дифференцировать оба пола и данный факт требует продолжения дальнейших исследований в этой области.

Ключевые слова

болгары, моляры, одонтометрические измерения, половой диморфизм