Clin Oral Invest (2012) 16:395–399
DOI 10.1007/s00784-011-0537-8

ORIGINAL ARTICLE

Sexual dimorphism in teeth? Clinical relevance

Ralf J. Radlanski · Herbert Renz · Werner Hopfenmüller

Received: 7 October 2010 / Accepted: 25 February 2011 / Published online: 10 March 2011

Abstract Many morphometric studies show a sexual dimorphism in human teeth. We wanted to know whether it is possible to determine the sex of an individual if only the anterior teeth are visible. Fifty intraoral photographs showing the front tooth region of female and male individuals (age: from 7 to 75 years) were randomly arranged in actual size on a questionnaire. The lip region was covered in each case. Besides "female" and "male", one was also able to check "?" if undecided. The questionnaires were distributed to 50 expert test persons (dentists, dental technicians, dental assistants, and students of dental medicine) and to 50 laymen and were all returned for evaluation. Although the correct sex was recognized on single photographs to a maximum of 76%, it was incorrect in 69% on other photographs. Altogether, the statistical evaluation showed that in most cases, the sex was only recognized correctly by one half, and incorrect by the other half. It can be concluded that a sexual dimorphism of human teeth—although measurable morphometrically—could not be recognized visually on the basis of photographs of the front tooth region. Neither experts in the field of dentistry nor laymen were able to properly distinguish between male and female teeth.

Keywords Sexual dimorphism · Teeth · Morphometry · Questionnaire

R. J. Radlanski (✉) · H. Renz
Center for Dental and Craniofacial Sciences,
Dept. of Craniofacial Developmental Biology,
Charité - Campus Benjamin Franklin at Freie Universität Berlin,
Assmannshauser Str. 4-6,
14197 Berlin, Germany
e-mail: ralfj.radlanski@charite.de
URL: http://oralstrukturbiol.charite.de

W. Hopfenmüller
Institute of Biometry and Clinical Epidemiology,
Charité - Campus Benjamin Franklin at Freie Universität Berlin,
Assmannshauser Str. 4-6,
14197 Berlin, Germany

Introduction

Usually, sexual dimorphism between female and male individuals is obvious. This is not only correct with respect to the overall architecture of the body, but also for details. So, as there is typically female skull morphology [1], there are abundant reports about sexual dimorphism in teeth. These findings are in particular based on morphometric studies. In general, it is maintained that female teeth are smaller than male teeth [2–7]. Findings are based on measurements of tooth diameter [4, 8–10], on three-dimensional measurements [6, 7, 11, 12], and on assessments of mass and weight [13]. Similar to some mammals, this should be particularly obvious in canines [9, 13]. However, there is also room for doubt [14].

For dental professionals, it is important to know whether these differences are relevant for each patient. Of course, regarding size, form, color, and arrangement during restorative treatment, it is well taken in mind, that the teeth match the features of the face or those of the whole body and person [15, 16]. Furthermore, it should be of importance whether there are any aesthetic parameters that refer to whichever sexual dimorphism in teeth. It was not our aim to test the morphometric studies, but we wanted to know whether the sex of an individual could be determined by visual inspection of the anterior teeth only. If so, morphological differences should be recognized subconsciously or intuitively.

We made use of questionnaires showing photographs of the frontal region of the dentition.

We assume that differences in sex can be distinguished by viewing the anterior teeth of male and female individuals. We further expect that dental professionals with their expert knowledge are more successful in distinguishing male from female individuals that way. Therefore, the test persons who were asked to fill in the questionnaires were selected accordingly.

Material and methods

Fifty photographs, selected at random among our orthodontic patients, showing the anterior region of the dental arches were reproduced on a questionnaire. Each image was taken from the frontal view, showing the upper and lower incisors and canines, the gingiva, and the alveolar mucosa. The lips, however, were not visible (Fig. 1 showing an example image) to prevent sex assessment from clues of the perioral region. Twenty-five of these photographs showed female and 25 showed male individuals. The age of the patients of whom the photographs were taken ranged between 7 (permanent incisors erupted) and 75 years. Each image was reproduced in natural size. In order to test the reliability of the questionnaire, four images were featured twice in different places, and two images were featured twice, mirrored horizontally. The questionnaires were given to 100 test persons who were asked to mark whether the teeth belong to a female or to a male person next to each image. In case no decision could be made, they were allowed to tick a question mark. Each test person was given the information that 50% of the images belonged to female and to male individuals, respectively. All test persons were above 18 years of age, and they filled out the questionnaire alone without any discussions with other people. Fifty test persons were laymen, meaning they did not belong to any dental profession. They were randomly selected from relatives of our patients. The other 50 test persons belonged to the dental profession: dentists (34%), students of dentistry in their last 2 years of clinical education (40%), dental assistants (18%), and dental technicians (8%). This

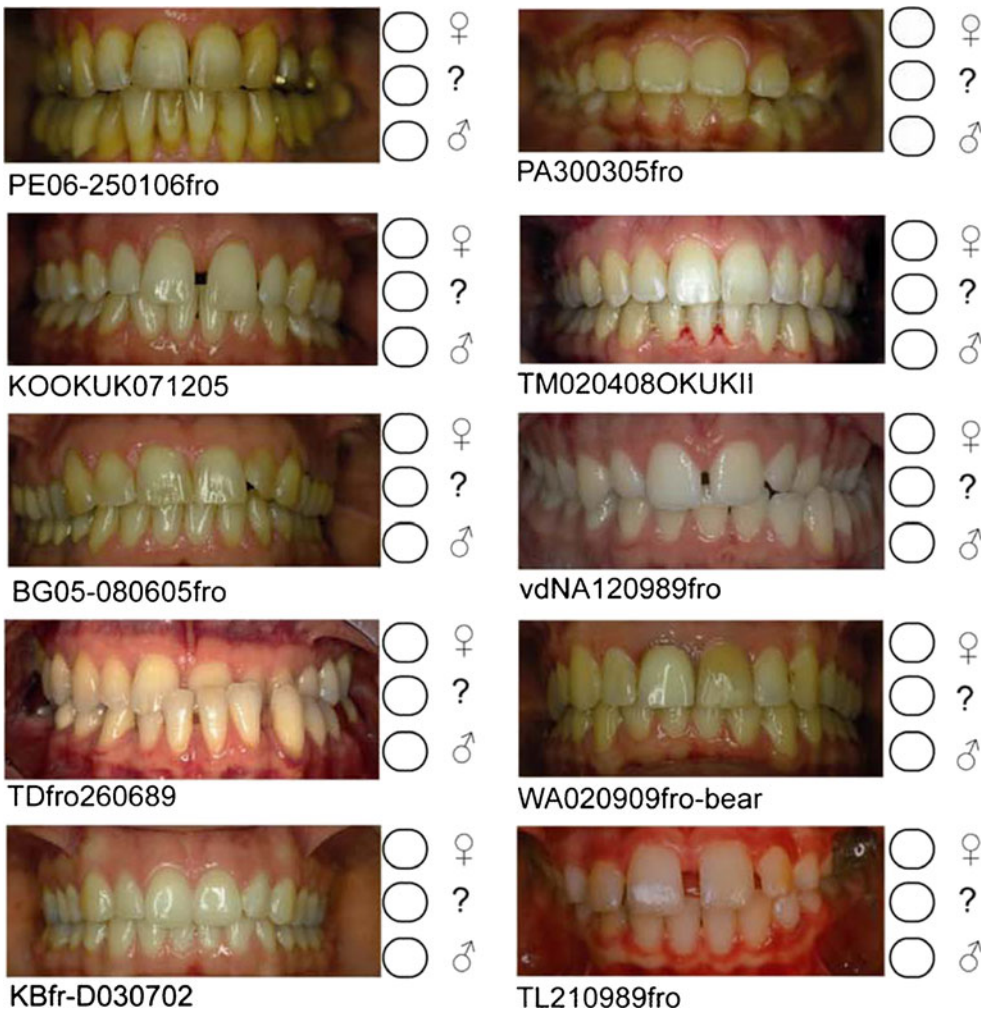

Fig. 1 Page 4 of the questionnaire. The images were shown at actual size. The questionnaire had five pages (DIN A4, US letter) in total

information was also marked on the questionnaire for statistical reasons. Of 100 test persons, 63 were female and 37 were male. All questionnaires were returned and subjected to statistical analysis.

All variables were summarized according to their type. Variables measured on a quantitative scale were summarized using descriptive statistics (median, quartiles, minimum and maximum, box-whisker plots because the percentages were not normally distributed). Variables measured on ordinal or nominal scales were summarized by use of frequency tables showing the number and percentage within a particular category. Statistical analyses were performed using SPSS, version 19.

Results

In photographs showing the dentition from a frontal view, it was impossible to distinguish female from male individuals (Fig. 2). The statistical evaluation showed that there were almost equal records of correct and incorrect evaluation. Not even dental professionals were superior in their judgment over laymen. Only the dental assistants showed a tendency to be more correct in their assessment, which was, however, not significant. There was also no difference in accuracy of assessment when images of only female (Fig. 3) or only male (Fig. 4) individuals were selected.

The four doubled images, which were scattered across the questionnaire for test reasons were not detected by the same test person in many cases. Error rates were up to 54%.

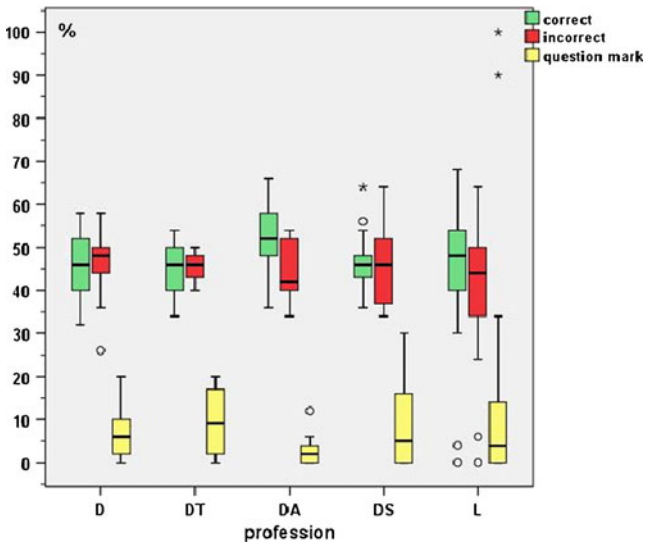

Fig. 2 Assessment of photographs in relation to professionals (D: dentists, DT: dental technicians, DA: dental assistants, DS: dental students) and laymen (L). Correct and incorrect assessments range almost equally in the 50% region, so sexual dimorphism was not recognized by the test persons

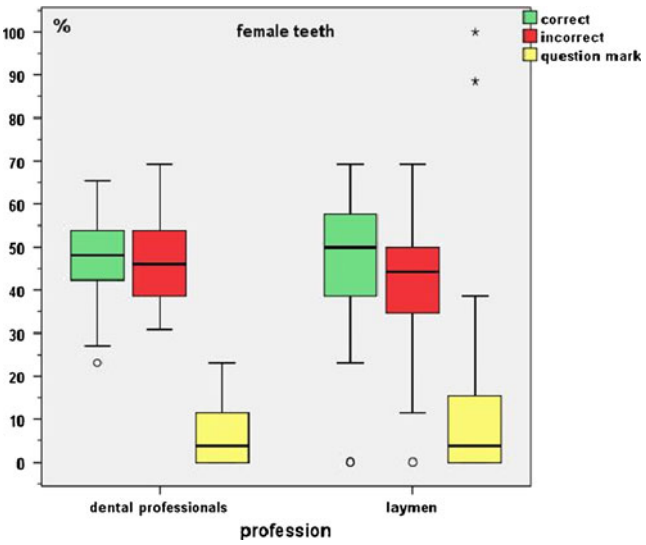

Fig. 3 Assessment of photographs showing female individuals in relation to professionals and laymen. Correct and incorrect assessments range almost equally in the 50% region, so sexual dimorphism was not recognized by the test persons

Even in the "most female" image (Fig. 5) characterized by the highest score of correct judgment (76%), there were 15% incorrect assessments, and 19% of the test persons were not able to decide and ticked the box with the question mark instead. The "most male" image (Fig. 6) was recognized only by 71% as a male dentition, 23% were incorrect, and 6% could not decide. The other way round, a certain dentition of a female was judged to be male by 58% (Fig. 7), and a male one judged to be female by 69% (Fig. 8). So, contrary to morphometric reports in the literature and to our assumption, dental sexual dimorphism

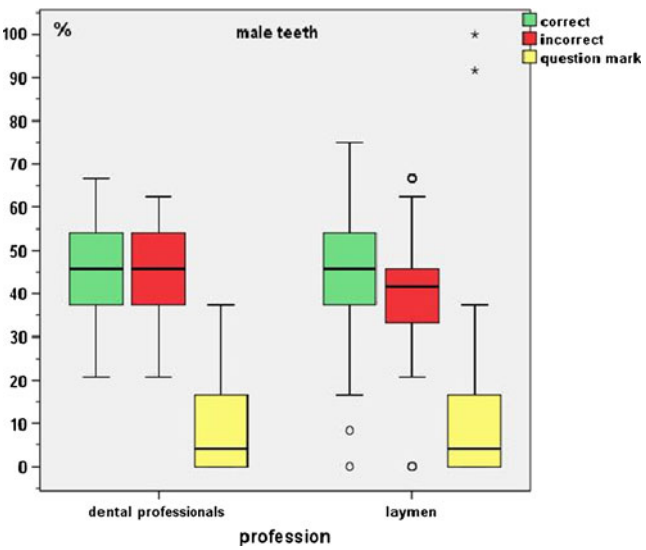

Fig. 4 Assessment of photographs showing male individuals in relation to professionals and laymen. Correct and incorrect assessments range almost equally in the 50% region, so sexual dimorphism was not recognized by the test persons

Fig. 5 This image shows the dentition of a female individual, which was best recognized correctly as a female. Correct assessment 76%, incorrect 14%, and question mark 10%

could not be recognized by the test persons in this study. Dental professionals were no more successful than laymen.

Discussion

Morphometric research in anthropology maintains that female teeth are smaller than male teeth [2–7]. This also holds correct for the deciduous dentition [6]. Although some people may think that female teeth are also more roundish and male teeth more sturdy as overall body physiology may suggest [15, 16], this is not correct. The female dental phenotype was shown rather downscaled from their male counterparts, but not gracile in form [11, 17]. Other studies showed a reverse dimorphism, which means female dental dimensions were larger than those of males in certain teeth [5]. Canines displayed greater sexual dimorphism in crown size than any other tooth class [9, 13], which, however, was also doubted [14]. In many studies, differences in size and proportion were found in molar teeth [18], whereas concerning the tuberculum carabelli (cusp of Carabelli), there was usually no sexual dimorphism either in the occurrence or in the degree of expression of character [19]. In the Jordanian population, however, sexual dimorphism was evident in Carabelli's trait on maxillary first molars [20]. Furthermore, male individuals showed a higher degree of shovel-shaped incisors [20].

Regarding tooth eruption and the so-called dental age (state of emergence of dentition), there are reports about differences between female and male individuals. In boys, the teeth tend to emerge about a month earlier [21] although their mineralization phase is delayed in comparison to that of girls, most markedly in canine mineralization, which was 20% later in boys [22]. In root development, the girls showed accelerated development [12]. Contrary to this, other studies show no statistically significant differences between the dental ages of girls and boys observed in particular age groups [23].

Fig. 7 This image shows the dentition of a female individual, which was at worst recognized correctly as a female. Correct assessment 26%, incorrect 58%, and question mark 16%

From this short compilation it becomes obvious that many morphometric studies show contradictory results. And our study clearly revealed that morphometric differences—whether measurable or not—cannot be perceived at this scale (Fig. 2). Neither laymen nor dental professionals could discriminate female from male teeth by visual inspection only as viewed from the front.

In habitual occlusion, the upper teeth normally overlap the lower teeth to a certain extent. The photographs were also taken in this relation. So, the lower teeth were hidden by one third or even more, which means, to a greater extent, the upper front teeth were the major feature to be evaluated by the test persons.

During lifetime, attrition may alter the shape of a tooth extremely. In our sample, as it was taken at random from our orthodontic patients, we had examples of no, moderate, and severe attrition. This may have had influenced the assessment of sex from visual inspection, but it must remain unknown in how much.

It is technically extremely difficult to measure teeth and look for differences because attrition alters the shape of each single tooth.

One may test the practical reliability of the quoted morphometric analysis by handing out a little bag filled with teeth to the experts who measured sex differences in human teeth [2–5, 7, 8, 11, 13, 17, 18, 24]. Would they be able to sort the teeth into a female pile and a male pile? For their defense one may say, however, in this questionnaire study that the test persons could see the teeth only in frontal views on photographs; there was no possibility to hold them in their fingers and view them from any side, as it can be done with extracted tooth specimens.

Fig. 6 This image shows the dentition of a male individual, which was at best recognized correctly as a male. Correct assessment 71%, incorrect 23%, and question mark 6%

Fig. 8 This image shows the dentition of a male individual, which was at worst recognized correctly as a male. Correct assessment 26%, incorrect 69%, and question mark 5%

Some sex-related features of the human body are clearly distinguishable, while some other male and female expressions of morphological traits are usually of a continuous nature. Teeth may also belong to those parts of the body that show a continuous transition of features from either sex. This may explain why some individuals were assessed more correctly than others, and why the test persons could not decide and score the question mark in several cases.

Different human populations may show different expressions of sexual dimorphism. In some populations, this dimorphism may be greater developed than in others. Therefore, studies which found no sexual difference in tooth size in one population do not necessarily contradict those which find differences in others. However, in times of globalization with free migration and reproduction, it is oftentimes impossible to define a "population", as it was done in times of the classical anthropological textbooks. Our sample of patients with their dental photographs selected for this study resembled the normal mixture of human individuals of Berlin (Germany) as a metropolitan area.

As they told us, during evaluation some test persons prejudiced that female teeth are more roundish while male teeth were expected to be more edged. Fig. 7 shows the direct contrary. The female individual showed the more edged teeth and the male individual revealed the more rounded teeth (Fig. 8). A further reason why these two images were assessed incorrectly by the majority may be the fact that these images displayed only the incisors as permanent teeth; the canines had not erupted yet. In this case, one may argue that the permanent canines are crucial for sex determination as some studies claim [9, 13]. As they informed us after having filled out the questionnaire, some other test persons were convinced that the more tidy, whiter, and better in shape teeth belonged to female individuals, whereas the more neglected teeth were identified as male teeth. As the evaluation of the questionnaire shows, this was not the right criterion either to determine sex from viewing the dentition from the front.

As a practical consequence, the dental practitioner cannot actively shape or restore teeth according to sex traits. Instead, one should be aware of how the tooth to be restored fits the face and the overall body form [15, 16]. A typical male or a typical female tooth form that can be recognized intuitively obviously does not exist.

Acknowledgments We thank Mrs. Beate Lion for her skillful assistance in preparing and conducting this study. We further thank Ms. Marion Bonner of eubylon GmbH for checking our manuscript as a native speaker.

Conflicts of interest The authors declare that they have no conflicts of interest.

References

1. Sjovold T (1988) Geschlechtsdiagnose am Skelett. In: Knußmann R (ed) Anthropologie. Fischer, Stuttgart, pp 444–480
2. Kieser JA (1990) Human adult odontometrics. The study of variation in adult tooth size. Cambridge University Press, Cambridge
3. Ling JY, Wong RW (2007) Tooth dimensions of Southern Chinese. Homo 58:67–73
4. Miethke RR (1972) Zahnbreiten und Zahnbreitenkorrelationen. Dissertation. Freie Universitaet, Berlin
5. Prabhu S, Acharya AB (2009) Odontometric sex assessment in Indians. Forensic Sci Int 192(129):e1–5
6. Teschler-Nicola M (1992) Sexualdimorphismus der Zahnkronendurchmesser. Ein Beitrag zur multivarianten Geschlechterbestimmung im Kindesalter anhand des frühbronzezeitlichen Gräberfeldes von Franzhausen I. Anthropol Anz 50:51–65
7. Teschler-Nicola M, Prossinger H (1998) Sex determination using tooth dimensions. In: Alt KW, Rösing FW, Teschler-Nicola M (eds) Dental anthropology. Fundamentals, limits, and prospects. Springer, Wien, pp 479–500
8. Black TK 3rd (1978) Sexual dimorphism in the tooth-crown diameters of the deciduous teeth. Am J Phys Anthropol 48:77–82
9. Hattab FN, al-Khateeb S, Sultan I (1996) Mesiodistal crown diameters of permanent teeth in Jordanians. Arch Oral Biol 41:641–645
10. Margetts B, Brown T (1978) Crown diameters of the deciduous teeth in Australian Aboriginals. Am J Phys Anthropol 48:493–502
11. Shields ED, Altschuller B, Choi EY, Michaud M (1990) Odontometric variation among American black, European, and Mongoloid populations. J Craniofac Genet Dev Biol 10:7–18
12. Frucht S, Schnegelsberg C, Schulte-Monting J, Rose E, Jonas I (2000) Dental age in southwest Germany. A radiographic study. J Orofac Orthop 61:318–329
13. Schwartz GT, Dean MC (2005) Sexual dimorphism in modern human permanent teeth. Am J Phys Anthropol 128:312–317
14. Acharya AB, Mainali S (2009) Limitations of the mandibular canine index in sex assessment. J Forensic Leg Med 16:67–69
15. Hörauf K (1958) Form und Stellung der Frontzähne in ihrer Beziehung zu Körperbautypen. Carl Hanser Verlag, München
16. Horn R (1985) Zur Brauchbarkeit der Dreiform-These nach Williams. Zahnärztl Prax 6:220–221
17. Haralabakis NB, Sifakakis I, Papagrigorakis M, Papadakis G (2006) The correlation of sexual dimorphism in tooth size and arch form. World J Orthod 7:254–260
18. Biggerstaff RH (1975) Cusp size, sexual dimorphism, and heritability of cusp size in twins. Am J Phys Anthropol 42:127–139
19. Alvesalo L, Nuutila M, Portin P (1975) The cusp of Carabelli. Occurrence in first upper molars and evaluation of its heritability. Acta Odontol Scand 33:191–197
20. Khraisat A, Taha ST, Jung RE, Hattar S, Smadi L, Al-Omari IK, Jarbawi M (2007) Prevalence, association, and sexual dimorphism of Carabelli's molar and shovel incisor traits amongst Jordanian population. Odontostomatol Trop 30:7–21
21. Tanguay R, Demirjian A, Thibault HW (1984) Sexual dimorphism in the emergence of the deciduous teeth. J Dent Res 63:65–68
22. Thompson GW, Anderson DL, Popovich F (1975) Sexual dimorphism in dentition mineralization. Growth 39:289–301
23. Rozylo-Kalinowska I, Kiworkowa-Raczkowska E, Kalinowski P (2008) Dental age in Central Poland. Forensic Sci Int 174:207–216
24. Iscan MY, Kedici P (2003) Sexual variation in bucco-lingual dimensions in Turkish dentition. Forensic Sci Int 137:160–164