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TECHNICAL NOTE

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Sex Discrimination Potential of Buccolingual and Mesiodistal Tooth Dimensions

ABSTRACT: Tooth crown dimensions are reasonably accurate predictors of sex and are useful adjuncts in sex assessment. This study explores the utility of buccolingual (BL) and mesiodistal (MD) measurements in sex differentiation when used independently. BL and MD measurements of 28 teeth (third molars excluded) were obtained from a group of 53 Nepalese subjects (22 women and 31 men) aged 19–28 years. Stepwise discriminant analyses were undertaken separately for both types of tooth crown variables and their accuracy in sex classification compared with one another. MD dimensions had recognizably greater accuracy (77.4–83%) in sex identification than BL measurements (62.3–64.2%)—results that are consistent with previous reports. However, the accuracy of MD variables is not high enough to warrant their exclusive use in odontometric sex assessment—higher accuracy levels have been obtained when both types of dimensions were used concurrently, implying that BL variables contribute to sex assessment to some extent. Hence, it is inferred that optimal results in dental sex assessment are obtained when both MD and BL variables are used together.

KEYWORDS: forensic science, dental anthropology, odontometrics, sex determination, linear tooth measurements, stepwise discriminant analysis

Sexual dimorphism in tooth size has been an area of interest to both anthropologists and forensic specialists (1–4). Although teeth cannot be used as the sole indicator of sex, studies indicate that they are a good adjunct for sex differentiation (1). Some believe that as many anatomical criteria as possible should be utilized for sexing skeletal specimens (5). Thus, teeth add value to forensic sex identification, particularly when more reliable diagnostic parameters such as the pelvis are not adequately preserved (1). Odontometrics has been explored as a tool for sex assessment in the forensic literature mostly in the past two decades (2–4,6–8). Of primary interest to examiners are the buccolingual (BL) and mesiodistal (MD) tooth dimensions, termed linear measurements. While measuring both would be ideal, it is not uncommon to find reports where one of the two has been examined (2,6,9). The present authors recently reported dental sexual dimorphism in both types of dimensions for a sample originating from Nepal and concluded that the presence of statistically significant univariate differences has little forensic significance (4); the need, instead, was to focus on multivariate discriminant analysis of teeth. The study indicated that MD variables had greater utility in sex assessment using discriminant analyses—in comparison to BL variables, more MD variables entered and contributed significantly to the stepwise discriminant analysis (4). Therefore, in this study, the authors have undertaken stepwise discriminant analyses separately for BL and MD dimensions to determine their accuracy in assessing sex. In addition, to assess whether each type of linear measurement can be used independently in odontometric sex differentiation, the precision of the analyses was compared to previous results on the same sample where BL and MD dimensions were both entered together (4). In the event either of the linear measurements can be used alone, it may prove time-effective and convenient for the forensic examiner obtaining tooth dimensions. Moreover, it makes the examiner less dependent on one type of tooth variable, allowing sexing even in its absence.

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Materials and Methods

The study examined and analysed the dentitions of 53 young adults from Nepal (22 women and 31 men) in the age group of 19–28 years. The subjects—all undergraduate students at the College of Dental Surgery, B.P. Koirala Institute of Health Sciences, Nepal—were requested to provide casts of their dentitions. Following informed verbal consent, impressions of the teeth were made using alginate material and the casts poured in dental stone. The MD and BL dimensions of all teeth, excluding third molars, were measured on the casts using a digital caliper (Mitutoyo, Japan; 0.01 mm calibration). The MD measurements were defined as the greatest dimension between the contact points on the approximate surfaces of the crown measured with the caliper beaks placed occlusally along the long axis of the tooth (10). In cases where the teeth were rotated or malposed, measurements were taken between points on the approximate surfaces of the crown where it was considered that contact with adjacent teeth would have normally occurred. The BL measurement was defined as the greatest distance between the labial/buccal surface and the lingual surface of the tooth crown measured with the caliper held at right angles to the MD dimension (10). On obtaining the measurements, three stepwise discriminant analyses (one for both jaws, one each for the maxilla and mandible) were performed separately for BL and MD dimensions using SPSS 10.0 statistical software program (SPSS Inc., Chicago, IL). The three analyses were undertaken considering the availability of both or either jaw in forensic scenarios.

Results and Discussion

The analysis of BL and MD dimensions separately helps gauge possible advantages of one over the other in sex assessment. Garn et al. (9) believed that dental sexual dimorphism is consistently greater for BL dimensions and recommend wider use of this type

of variable. More recently, İşcan and Kedici (2) stated that an advantage of BL dimensions is that they are more reliably measured than others. While this is probably true for the posterior teeth, it has been reported that measuring BL dimensions of the maxillary and mandibular incisors can be challenging at times (4). Moreover, the presence of dental calculus around the cervical third (neck of the tooth) may warrant careful cleaning of the teeth prior to obtaining BL measurements on skeletal specimens. Furthermore, BL measurements may be undermined by cervical abrasion. Lesions, restorations (fillings), and cracking of teeth may also render BL dimensions, as well as MD variables, unusable (1,8). The major disadvantage of MD measurements is that they are more difficult to obtain than BL measurements, considering the proximal contact that exists between teeth. Ease in obtaining MD measurements may also be undermined by crowding in the anterior segment of the jaws and altered tooth alignment in general. Also, excessive attrition and interproximal wear facets can alter MD dimensions. However, MD dimensions of canines, particularly mandibular, is widely shown to exhibit the greatest sexual dimorphism among tooth crown measurements (4,10–12). Considering the advantages and disadvantages of both types of variables, it seems reasonable that their ability to discriminate the sexes independently should be explored. This could validate the exclusive use of either in odontometric sex assessment.

Table 1 shows the BL and MD tooth variables that contributed to the stepwise discriminant analysis. Wilks' lambda denotes how useful a given tooth variable is in the stepwise discriminant analysis and determines the order in which the variables entered the analysis, while the *F* statistic determines how much variation exists between the sexes and the significance level of the variance (13). A single tooth—the mandibular left canine or the maxillary right first molar—entered each stepwise discriminant analysis undertaken for the BL variables. For MD variables, the mandibular right canine contributed most to sex differentiation followed by the maxillary right first premolar. These variables had also contributed to the stepwise discriminant analysis when BL and MD dimensions were entered together (4). The cross-validated sex classification accuracy for BL and MD variables is presented in Table 2. The highest accuracy rate of assessing sex was obtained for MD variables from both jaws. Stepwise discriminant analyses for maxillary and mandibular MD variables gave the next best classification accuracy. The MD variables were systematically better in sex identification than BL dimensions—all stepwise discriminant analyses for MD variables differentiated the sexes with an accuracy of >77%, while none of those for BL dimensions exceeded 64.2%. In all stepwise discriminant analyses for MD variables, at least two teeth contributed to sex differentiation whereas a single BL tooth variable entered the corresponding analysis (Table 1). It is plausible that the inability of additional BL variables to enter the stepwise discriminant analysis is responsible for their relatively low accuracy.

The higher accuracy of MD stepwise discriminant analyses appears to be an extension of previous observations on the same sample, where MD variables contributed more to stepwise discriminant analysis even in the presence of BL variables (4). Potter (14) has also observed that MD variables contributed more to stepwise discriminant analysis—10 out of 12 variables that entered the analysis in her study were MD dimensions. Garn et al. (15), too, reported lower discriminatory ability of BL measurements relative to MD dimensions, the latter sexing individuals with an accuracy level as high as 86%—a figure comparable to our results (Table 2). İşcan and Kedici (2) performed stepwise discriminant analyses only for BL dimensions and could differentiate sex with a precision of up to 77%, an accuracy level they considered as being low. With the exception of Ditch and Rose (1), in every study where discriminant analyses were undertaken using both BL and MD variables, the latter has entered the discriminant analysis first (4,12,14,15). This shows their consistent ability to contribute more to this type of multivariate sex assessment. These findings suggest that MD variables, as a unit, have greater utility in sex differentiation than BL variables. A reason why MD dimensions have better sex discriminatory ability could be that these variables are related to the maxillary and mandibular arch dimension—considering the observations that antero-posterior jaw measurements are statistically larger in males (16) and that arch size influences tooth size (17), one may infer that larger jaws in males result in correspondingly larger MD dimensions.

Although BL dimensions are more easily measured (and may be conveniently obtained on occlusally worn teeth in forensic scenarios), their ability to correctly sex an individual is moderate when used independently. If one has the option of choosing between the two types of linear measurements, MD dimensions should be preferred. Nevertheless, BL measurements elevate sex discrimination outcome when combined with MD dimensions, as shown

TABLE 1—*Stepwise discriminant analysis of buccolingual and mesiodistal variables.**

Variables Entered	Wilks' Lambda Statistic	Exact *F* Statistic†	DF 2
All BL variables‡			
Mandibular left canine	0.786	13.863	1.51
Maxillary BL variables			
Right first molar	0.818	11.357	1.51
Mandibular BL variables			
Left canine	0.786	13.863	1.51
All MD variables‡			
Mandibular right canine	0.715	20.368	1.51
Maxillary right first premolar	0.499	25.074	2.50
Maxillary MD variables			
Left canine	0.826	10.746	1.51
Right first premolar	0.683	11.582	2.50
Mandibular MD variables			
Right canine	0.715	20.368	1.51
Left first premolar	0.589	17.437	2.50
Left central incisor	0.543	13.765	3.49

*At each step, the variable that minimizes the overall Wilks' Lambda is entered. Minimum partial *F* to enter is 3.84; maximum partial *F* to remove is 2.71.

†*F*-values are all significant at $p < 0.01$ level.

‡All 28 buccolingual and mesiodistal variables, respectively, were included in the analysis.

TABLE 2—*Classification results of the cross-validated discriminant analysis.**

	Male		Female		
Stepwise Discriminant Analyses	*n*	%	*n*	%	Total Average (%)
All BL variables	19/31	61.3	15/22	68.2	64.2
Maxillary BL variables	20/31	64.5	13/22	59.1	62.3
Mandibular BL variables	19/31	61.3	15/22	68.2	64.2
All MD variables	25/31	80.6	19/22	86.4	83.0
Maxillary MD variables	26/31	83.9	15/22	68.2	77.4
Mandibular MD variables	24/31	77.4	17/22	77.3	77.4

*Cross-validation (or jackknifing) is done only for those cases in the analysis. In cross-validation, each case is classified by the functions derived from all cases other than that case.

previously by the authors (4). Hence, their utility in sex assessment should not be disregarded.

In summation, stepwise discriminant analyses were performed separately for BL and MD tooth dimensions and their accuracy in sex assessment compared. The analyses undertaken for MD measurements could discriminate sex better than those for BL dimensions. However, the accuracy levels of the analyses for MD variables are lower to those derived by combining BL and MD dimensions. Although MD measurements are better suited than BL dimensions for sex discrimination when used independently, best results in dental sex assessment are obtained when both are considered together.

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