

Odontometric Sex Assessment Using Diagonal Measurements of Maxillary First Premolar and Maxillary First Molar Teeth in Nagpur Population.

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ABSTRACT

Determining gender using dental features is mainly achieved by comparing the tooth dimensions in males and females using traditional mesiodistal and buccolingual crown diameters of teeth. According to Hilson et al., most of the archaeological and fossil remains of human teeth exhibit heavy attrition of usual crown diameters but alternative diagonal measurements are not affected until later stages of wear.

Aims and objectives: This study aimed to evaluate and estimate the accuracy of using Maxillary 1st Premolar and Permanent Maxillary 1st Molar for gender determination in Nagpur Population.

Material and Methods: Study sample included 100 Maxillary dental casts obtained by alginate impression from 50 males and 50 females of the age group of 17-25 years selected from Nagpur (India). Using the Diagnostic dental casts, mesiobuccal-distolingual and distobuccal-mesiolingual measurements were taken separately. All the measurements were taken from both right and left sides using a 6" digital Vernier calliper of 0.01mm resolution.

Results: The results of present study suggest that the diagonal measurements were significantly greater in males than females. These results were in accordance with various other studies revealing clear dimorphic differences between male and female teeth.

Conclusion: Thus, the study concludes that Cervical diagonal diameters of Molars can be used as an aid for sex determination in support of width measurements and also as an aid in identifying a person from fragmented jaws and dental archaeological remains. However, this study needs further evaluation in other populations as sexual dimorphism is a population specific phenomenon.

KEYWORDS: Distobuccal-mesiolingual, Mesiobuccal-distolingual, Diagonal measurements, Sexual dimorphism.

I. INTRODUCTION

Odontometry has been performed on various tooth groups with the objective of establishing measurements that can act as standards, and this may also facilitate some procedures of the dental surgeon, as well as in forensic odontology.¹ Teeth being resistant to postmortem destruction and being chemically stable are an excellent material for odontologic and forensic investigations.²

Gender determination is crucial for identification, as the number of possible matches is reduced by 50%.³ Tooth size measurements based on odontometric investigations in a specific population can be used in gender determination.²

Determining gender using dental features is mainly achieved by comparing the tooth dimensions in males and females using traditional mesiodistal and buccolingual crown diameters of teeth.⁴ But these dimensions get affected by attrition, interproximal wear facets, cervical abrasions, crowding, and presence of dental calculus in cervical third.³ Further, these dimensions are difficult to measure when the teeth are still held in socket.^{4,5} As a result, alternative measurements including the crown and cervical diagonal diameters were developed. According to Hilson et al., most of the archaeological and fossil remains of human teeth exhibit heavy attrition of usual crown diameters but alternative diagonal measurements are not affected until later stages of wear. Exclusion of contact points remains one of the major advantages of diagonal diameters of molars. The diagonal diameters proposed by Hilson et al., included Mesiobuccal-distolingual crown diameter, Mesiolingual-distobuccal crown diameter, Mesiobuccal-distolingual cervical diameter and Mesiolingual-distobuccal cervical diameter.⁶

II. AIMS AND OBJECTIVES

This study aimed to evaluate and estimate the accuracy of using Maxillary 1st Premolar and Permanent Maxillary 1st Molar for gender determination in Nagpur Population.

III. MATERIALS AND METHODS

Study sample included 100 Maxillary dental casts obtained by alginate impression from 50 males and 50 females of the age group of 17-25 years selected from Nagpur (India).

Selection criteria included fully erupted Maxillary 1st Premolar and Permanent Maxillary 1st Molar. Teeth with marked wear or heavily restored were excluded from the research. Diagonal measurements of crown and cervix of Maxillary 1st Premolar and Permanent Maxillary 1st Molar were taken.

Using the Diagnostic dental casts, mesiobuccal-distolingual and distobuccal-mesiolingual measurements were taken separately. All the measurements were taken from both right and left sides using a 6" digital Vernier calliper of 0.01mm resolution.

When placing the caliper parallel to the occlusal surface, the following points were taken as guide during the measurements as defined by Hilson et al.

MBDL: the largest distance between the mesiobuccal corner and the distolingual corner of the crown

DBML: the largest distance between the distobuccal corner and the mesiolingual corner of the crown

Mesiobuccal–distolingual cervical diameter (cervical MBDL) is defined as the maximum distance from the mesiobuccal corner of cemento–enamel junction point to the distolingual corner.

Mesiolingual–distobuccal cervical diameter (cervical MLDB) is defined as the maximum distance from the mesiolingual corner of cemento–enamel junction point to the distobuccal corner.

Two crown and two cervical diagonal measurements of Maxillary 1st Premolar and Permanent Maxillary 1st Molar were taken. Each dimension was measured twice at a different time interval by the different observer.

IV. STATISTICAL ANALYSIS

The collected data was subjected to statistical analysis. The data was subsequently processed and analyzed using the SPSS software package version 17.

- 1) Duration of Study: 6 Months.
- 2) Type of Study: Retrospective study.

V. RESULTS

Four diagonal measurements on each tooth (including two cervical and two crown), altogether 16 measurements on both sides, were obtained in each of the individuals. Each measurement was measured twice at two different intervals by the same examiner to check for intra observer error. There was no statistically significant difference between the first and second measurements made as shown in [Table 1].

The results of present study suggest that the diagonal measurements were significantly greater in males than females. These results were in accordance with various other studies revealing clear dimorphic differences between male and female teeth.

Table 1: Paired t-test evaluating intra-observer variation in crown (Cr) and cervical (Cer) diagonal measurements of 1st premolar (PM) and 1st molar(M) (of both right and left sides).

Males						T value	P value
		Mean	N	Std. Deviation	Std. Error Mean		
Rt1stPMCrM BDL	1st observer	0.7408	25	0.04830	0.00966	-4.303	0.000
	2 nd observer	0.7464	25	0.04751	0.00950		
Rt1stPMCrD BML	1st observer	0.771	25	0.0830	0.0166	1.29	0.209
	2 nd observer	0.758	25	0.0800	0.0160		
Rt1stPMCer MBDL	1st observer	0.8100	25	0.07762	0.01552	0.549	0.588
	2 nd observer	0.8076	25	0.07731	0.01546		
Rt1stPMCer DBML	1st observer	0.803	25	0.0686	0.0137	1.988	0.058
	2 nd observer	0.776	25	0.0659	0.0132		
Rt1stMCrMB DL	1st observer	0.9004	25	0.10803	0.02161	1.149	0.262
	2 nd observer	0.8880	25	0.10071	0.02014		
Rt1stMCrDB ML	1st observer	0.91	25	0.116	0.023	0.397	0.695
	2 nd observer	0.90	25	0.107	0.021		
Rt1stMCerM BDL	1st observer	1.012	25	0.1402	0.0280	1.913	0.068
	2 nd observer	0.973	25	0.1208	0.0242		
Rt1stMCerD BML	1st observer	0.9848	25	0.13718	0.02744	-1.602	0.122

	2 nd observer	1.0060	25	0.15036	0.03007		
Lt1stPMCrM BDL	1st observer	0.7000	25	0.17059	0.03412	0.00	1.00
	2 nd observer	0.7000	25	0.16785	0.03357		
Lt1stPMCrD BML	1st observer	0.789	25	0.0860	0.0172	1.639	0.114
	2 nd observer	0.771	25	0.0665	0.0133		
Lt1stPMCer MBDL	1st observer	0.80	25	0.085	0.017	0.067	0.947
	2 nd observer	0.80	25	0.087	0.017		
Lt1stPMCer DBML	1st observer	0.821	25	0.0812	0.0162	0.601	0.553
	2 nd observer	0.815	25	0.0729	0.0146		
Lt1stMCrMB DL	1st observer	0.91	25	0.104	0.021	1.82	0.081
	2 nd observer	0.90	25	0.083	0.017		
Lt1stMCrDB ML	1st observer	0.8848	25	0.10369	0.02074	0.337	0.739
	2 nd observer	0.8832	25	0.09529	0.01906		
Lt1stMCerM BDL	1st observer	1.006	25	0.1277	0.0255	0.129	0.898
	2 nd observer	1.004	25	0.1106	0.0221		
Lt1stMCerD BML	1st observer	1.062	25	0.1325	0.0265	2.066	0.05
	2 nd observer	1.04	25	0.108	0.022		

Table 2

Female

		Mean	N	Std. Deviation	Std. Error Mean	T Value	P Value
Rt1stPMCr MBDL	1st observer	0.6314	25	0.08862	0.01772	-0.668	0.51
	2 nd observer	0.6336	25	0.08688	0.01738		
Rt1stPMCr DBML	1st observer	0.7340	25	0.06513	0.01303	-0.459	0.65
	2 nd observer	0.736	25	0.0660	0.0132		
Rt1stPMCer MBDL	1st observer	0.8328	25	0.06542	0.01308	-2.138	0.043
	2 nd observer	0.841	25	0.0651	0.0130		
Rt1stPMCer DBML	1st observer	0.83920	25	0.100070	0.020014	2.003	0.057
	2 nd observer	0.8328	25	0.09693	0.01939		
Rt1stMCrM BDL	1st observer	1.14300	25	0.168640	0.033728	1.376	0.181
	2 nd observer	1.134	25	0.1758	0.0352		
Rt1stMCrD BML	1st observer	0.854	25	0.2348	0.0470	0.00	1.00
	2 nd observer	0.854	25	0.2376	0.0475		
Rt1stMCer MBDL	1st observer	1.517	25	0.1374	0.0275	-1.115	0.259
	2 nd observer	1.524	25	0.1439	0.0288		
Rt1stMCerD BML	1st observer	1.0666	25	0.16055	0.03211	-0.966	0.344
	2 nd observer	1.080	25	0.1634	0.0327		
Lt1stPMCr MBDL	1st observer	0.631	25	0.1034	0.0207	0.744	0.464
	2 nd observer	0.627	25	0.1022	0.0204		
Lt1stPMCr DBML	1st observer	0.718	25	0.0870	0.0174	0.253	0.802

	2 nd observer	0.717	25	0.0910	0.0182		
Lt1stPMCer MBDL	1st observer	0.7616	25	0.08410	0.01682	-0.941	0.356
	2 nd observer	0.765	25	0.0853	0.0171		
Lt1stPMCer DBML	1st observer	0.828	25	0.0916	0.0183	0.267	0.792
	2 nd observer	0.827	25	0.0955	0.0191		
Lt1stMCrM BDL	1st observer	1.11	25	0.170	0.034	-0.693	0.495
	2 nd observer	1.12	25	0.168	0.034		
Lt1stMCrD BML	1st observer	.8710	25	0.10941	0.02188	-0.674	0.507
	2 nd observer	.8748	25	0.10955	0.02191		
Lt1stMCer MBDL	1st observer	1.2740	25	0.12774	0.02555	-0.339	0.737
	2 nd observer	1.276	25	0.1299	0.0260		
Lt1stMCerD BML	1st observer	1.1700	25	0.10235	0.02047	-1.087	0.288
	2 nd observer	1.187	25	0.1224	0.0245		

Figure 1: Percentage of sexual dimorphism of right side 1st premolar and 1st molar

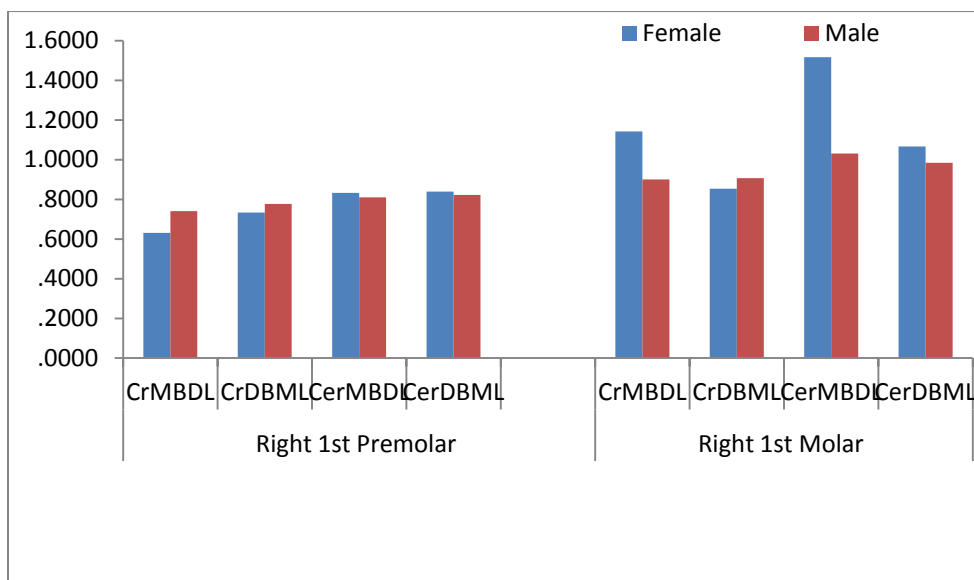


Figure 2: Percentage of sexual dimorphism of left side 1st premolar and 1st molar

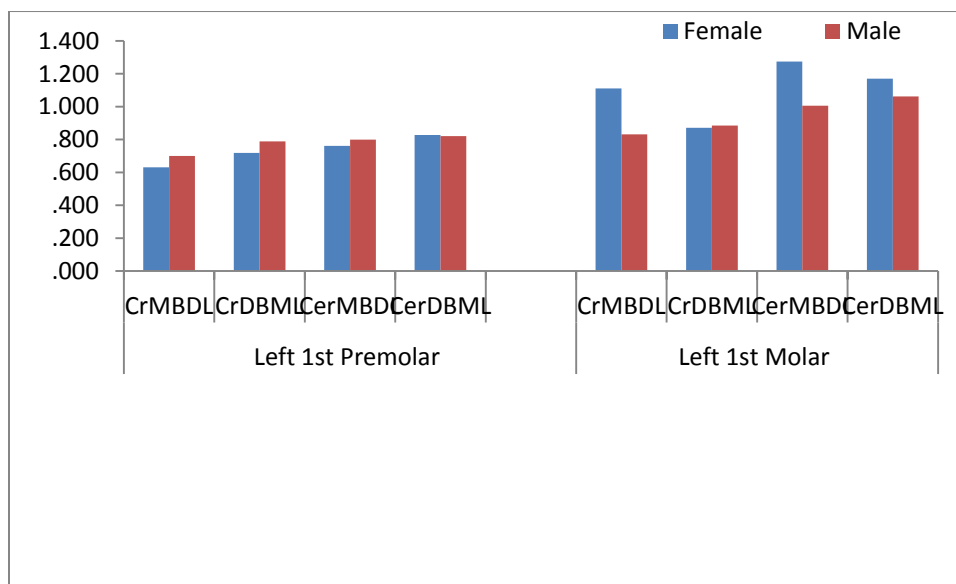


Table 3: Accuracy of classification results in determining gender.

Predicted group membership

Variable	Male (%)	Female (%)	Total average (%)
Rt1stPMCrMBDL	98.19	96.54	97.36
Rt1stPMCrDBML	74.01	89.26	81.63
Rt1stPMCerMBDL	88.65	91.94	90.29
Rt1stPMCerDBML	79.34	97.84	88.59
Rt1stMCrMBDL	75.46	96.90	86.18
Rt1stMCrDBML	73.23	98.94	86.08
Rt1stMCerMBDL	87.70	95.35	91.52
Rt1stMCerDBML	80.60	83.50	82.05
Lt1stPMCrMBDL	99.74	93.93	96.83
Lt1stPMCrDBML	92.9	93.24	93.07
Lt1stPMCerMBDL	88.50	96.02	92.26
Lt1stPMCerDBML	75.13	97.62	86.37
Lt1stMCrMBDL	74.96	96.18	85.57
Lt1stMCrDBML	95.07	93.48	94.27
Lt1stMCerMBDL	87.20	96.70	91.95
Lt1stMCerDBML	77.96	60.45	69.20

Table 4: Accuracy of determination of gender using upper 1st Premolar and 1st Molar

Accuracy of classification results			
Function	Predicted group membership		
	Male (%)	Female (%)	Total average (%)
1 st Premolar	78	75	76
1 st Molar	95	91	93

Table 5: Accuracy of determination of gender using crown and cervical measurements

Accuracy of classification results			
Function	Predicted group membership		
	Male (%)	Female (%)	Total average (%)
Crown	81	84	83
Cervical	92	94	93

VI. DISCUSSION:

Teeth have been the focus of interest for various forensic odontogenic studies as they are the most durable tissue in the body. Teeth are an excellent material in living and non-living populations for anthropological, genetic, odontologic and forensic investigations. Their durability in the face of fire and bacterial decomposition makes them invaluable for identification.⁷ Hence, teeth are of paramount importance when more robust predictors such as the pelvis or long bones are destroyed or fragmented.⁸

However, a variety of factors contribute to the magnitude of dimorphism in the teeth. One of the major cause being, environmental influence due to variation in food resources of different populations. Further, there can also be complex interaction between genetic and environmental factors resulting in variation in the magnitude of dimorphism in the teeth. Garn et al., has proposed that teeth through the course of evolution behave in many ways ranging from reduction of the entire dentition to reduction of one group of teeth in relation to other.⁹

Sexual dimorphism of teeth has been studied by many researchers and it has been reported that permanent teeth are highly dimorphic¹⁰. According to Kalia S, difference in the balance of hormonal production between the sexes consequent to the differentiation of either male or female gonads during the sixth or seventh week of embryogenesis attributed to the difference in sizes of teeth rather than any direct effect of sex chromosomes themselves.¹¹

In forensics, mesio-distal and bucco-lingual width measurements have been routinely used for gender determination. These measurements provide accurate results and are suggested to be the preferred method if width measurements are possible. But conditions like tooth rotations, crowding, orthodontic anomalies, occlusal attrition, Mesio-Occlusal, Disto-Occlusal, Mesio-Occluso-Distal fillings may prevent one from taking accurate width measurements. In those situations, diagonal measurements would be of help in determining gender and also these diagonal axes do not include the contact points of the crown, and are therefore not affected by proximal attrition until the facets become large enough to include them.⁶ But caution is needed in taking diagonal measurements as measurements will go wrong if the calipers are not placed correctly.¹²

The study aimed to evaluate and estimate the accuracy of using Maxillary 1st Premolar and Permanent Maxillary 1st Molar for gender determination in Nagpur Population.

The results of present study suggest that the diagonal measurements were significantly greater in males than females. These results were in accordance with various other studies revealing clear dimorphic differences between male and female teeth.

In a study performed over Modern Greek population similar to that of the present study cervical diagonal diameters of molars were found to be more sexually dimorphic than crown diagonal diameters. Analysis of the data generated revealed that diagonal measurements can be a useful aid in gender determination especially in situations where width measurements are not applicable.¹³

According to Hilson et al., alternative diagonal measurements were as reliable as normal width measurements and remain a promising method for sex determination. Diagonal measurements would be better measures for worn out teeth in archeological and fossil dental remains.⁶ Cervical measurements are not affected until most of the tooth is lost and thereby offer greater advantage in archaeological specimen identification.⁶

But taking diagonal measurements has got certain limitations as the measurements are most difficult to obtain and require more attention. Measurements might go wrong if the caliper is not positioned properly parallel to tooth axis.

The method applied in the present study is simple, inexpensive and can therefore be applied in forensic odontology for establishing gender identity of an individual.

In near future, digital imaging techniques might be available to measure different aspects of tooth size and shape which are not strongly affected by wear.

Thus, in future alternative diagonal measurements should find wider usage along with conventional width measurements.

VII. CONCLUSION

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Forensic odontology, depends a lot on simple and economical methods to identify persons with their dental remains and fragmented jaws. A dentist may be called upon to render expertise in forensic science, in such conditions.

All the 16 measurements taken revealed maximum greater values in males than in females and the differences were less significant. Highly significant dimorphic measurements included right molar cervical MBDL followed by right molar crown MBDL, left molar cervical MBDL and left molar crown MBDL [Figure1&2]. All the values on right side of premolar and molar region were comparatively equal with left side, except for molar cervical MBDL values [Figure1&2]. Overall classification accuracy of results was 87% with males and 83% females with accuracy rate being higher in Males [Table 4]. Accuracy rate was higher in molar than with premolar as shown in [Table 4] and Cervical measurements were found to be more reliable than crown measurements [Table 5].

Thus, the study concludes that Cervical diagonal diameters of Molars can be used as an aid for sex determination in support of width measurements and also as an aid in identifying a person from fragmented jaws and dental archaeological remains. However, this study needs further evaluation in other populations as sexual dimorphism is a population specific phenomenon.

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