ORIGINAL RESEARCH

A Comparative Evaluation of 2D and 3D Ante mortem Dental Records for Gender Determination among West Godavari Population.

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Abstract

Introduction: When it comes to the scientific recognition of human antemortem and postmortem dental data, the comparative approach of dental identification is quite helpful. Forensic dental identification methods typically use radiological documentation techniques and also routine use of 2-Dimensional (2D) imaging techniques to generate the viable structure of the tooth which cannot orient the deepness of the internal structure.

Discussion: The quantity and quality of antemortem (AM) dental records is extremely inconsistent and also analysing these different scans is tedious and time consuming. Hence to create a robust identification system, a novel 3-Dimensional (3D) model is used in human identification as an helpful tool in analysis and visualization. The main objective of this study is to evaluate the effectiveness and accuracy of 2D and 3D antemortem records in gender estimating.

Objectives: Maxillary dental casts and digital photos of 100 participants—50 male and 50 female—all of whom were orthodontic patients prior to receiving treatment were used for the data collection.

Conclusion: We concluded that 3D technique is more efficient and accurate for gender estimating than 2D technique. Documenting similar observations with larger sample sizes will enable the use of each form of linear measurement in odontometric gender distinction. This procedure will be of great value in storing patient information in the form of 3D models for identifying a stranger.

Keywords: 3D, 2D, Gender estimation.

Introduction

Dental identification is a comparative method which is very useful in scientific recognition of human ante-mortem and post-mortem dental data. The basis of forensic odontology is the characteristics of the human dentition, including dental alignment and orientation, which includes tooth form, arch, and dental treatment. Forensic dental identification methods typically use radiological documentation techniques and also routine use of 2-Dimensional (2D) imaging techniques to generate the viable structure of the tooth which cannot orient the deepness of the internal structure. Moreover, the quantity and quality of antemortem (AM) dental records is extremely inconsistent and also analysing these different scans is tedious and time consuming. Hence to create a robust identification system, a novel 3-Dimensional (3D) model is used in human identification as an helpful tool in analysis and visualisation.[1]

The future of forensic odontology depends much on the use of 3D datasets for comparison. Gender estimation is one of the initial steps in the identification process, which can make identification challenging but also narrows the search scope in emergency situations like fires or accidents. Although DNA is now the most reliable method, it is not always applicable.[2,3] Major factors in predicting gender also include palatal rugae[4], maxillary sinus, and mandibular ramus. As teeth are the most resilient structures in the body and can withstand temperatures of 1600 degrees Celsius without significantly losing microstructure, they are a more

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significant source of data than skeletal remains, which have been used to estimate gender.[5,6,7]

Results from dental examinations and comparisons of antemortem and postmortem radiographs and dental records are quite simple and highly reliable. Teeth are therefore a great source material for forensic, anthropological, genetic, and orthopaedic studies.[8] Human identification is currently mostly done using 2D techniques, with photographs of the subject offering more detailed information, particularly on the anterior dentition.[9] Since they might be accessible to friends, relatives, or through social media.

When there are no other relevant data for study, these photos can serve as an alternate antemortem dental source. Opportunities for precise techniques for forensic investigations have emerged with the advent of 3D technology, optical laser scanners, 3D printing[10] and intraoral scanners.[11,12]

This study suggests an intelligent approach that uses digital 2D and 3D scans (Exocad software) of a plaster model of the maxillary anterior teeth to establish gender. The purpose of this study was to investigate new odontological techniques by contrasting 2D digital photos with 3D scanned images using Exocad software. This was done in an effort to lessen the limitations of 2D methods as a useful tool for supporting forensic experts in making appropriate conclusions by providing accurate dental identification methods.

Materials and Methods

The institutional ethics committee approved the study protocol, with IEC No: IECVDC/2021/PG01/OP/IVT/05. In the southern state of India, a cross-sectional comparative study was carried out. With a power of 95%, an effect size of 0.73 at a significance level of 5%, and an expected total sample size of 100, the sample size was determined using the G-power 3.1 software. Photographs with maxillary anterior teeth were included, representing orthodontic patients aged 13 to 35 who had permanent maxillary anterior teeth (canine to canine). Individuals who had congenitally lost teeth, anterior prosthesis, compromised periodontal disease, wasting diseases, developmental or pathological anomalies, or carious teeth were not accepted.

Patients' concerns were referred to the orthodontic department at Vishnu Dental College in Andhra Pradesh so that their records could be used for research. The digital images of

Table 1: Multivariate analysis of odontometric variables in males and females in 3D

VARIABLES	MALE			FEMALE			P VALUE
	Mean	Std. Deviation	CV%	Mean	Std. Deviation	CV%	
11 MD INCISAL THIRD	9.1280	.83886	9.19	8.9000	.84298	9.47	.178
11 MD MIDDLE THIRD	9.3820	.79711	8.50	9.1500	.76645	8.38	.141
11 LP INCISAL THIRD	2.0040	.35855	17.89	2.1620	1.53621	71.06	.480
11 CROWN LENGTH	10.7360	1.52473	14.20	10.2180	.97911	9.58	.046*
12 MD INCISAL THIRD	6.9980	1.21915	17.42	7.1820	1.26841	17.66	.461
12 MD MIDDLE THIRD	7.7840	1.00820	12.95	7.9460	.88990	11.20	.396
12 LP INCISAL THIRD	1.7160	.38564	22.47	1.7080	.37788	22.12	.917
12 CROWN LENGTH	9.0300	1.28956	14.28	8.8680	1.14294	12.89	.508
13 MD INCISAL THIRD	6.8000	1.44928	21.31	6.5700	1.61779	24.62	.456
13 MD MIDDLE THIRD	8.5820	.76203	8.88	8.1200	.84370	10.39	.005*
13 LP INCISAL THIRD	2.3540	.35063	14.90	2.3040	.47636	20.68	.551
13 CROWN LENGTH	9.9980	1.45595	14.56	9.1640	1.03997	11.35	.001*
21 MD INCISAL THIRD	9.0960	.88062	9.68	8.9800	.83910	9.34	.502
21 MD MIDDLE THIRD	9.5580	.78898	8.25	9.4420	.96195	10.19	.511
21 LP INCISAL THIRD	1.9740	.38002	19.25	1.8520	.36379	19.64	.104
21 CROWN LENGTH	10.5400	1.50387	14.27	10.2320	.92834	9.07	.221
22 MD INCISAL THIRD	6.9100	1.31805	19.07	7.1060	1.35080	19.01	.464
22 MD MIDDLE THIRD	7.9680	1.01949	12.79	7.9060	.99743	12.62	.759
22 LP INCISAL THIRD	1.6480	.40970	24.86	1.5960	.43937	27.53	.542
22 CROWN LENGTH	9.3480	1.47070	15.73	8.8660	1.07468	12.12	.064
23 MD INCISAL THIRD	6.7600	1.50807	22.31	6.5480	1.54632	23.62	.489
23 MD MIDDLE THIRD	8.6420	.72677	8.41	8.2880	.78419	9.46	.021*
23 LP INCISAL THIRD	2.1680	.33224	15.32	2.1440	.48199	22.48	.773
23 CROWN LENGTH	9.9040	1.41781	14.32	9.4540	1.25799	13.31	.096

the patient, which were taken with a DSLR camera by a clinical photographer, were gathered together with the pre-treatment orthodontic dental casts (Canon DS126701). Photos showing the front teeth in a smile and unbroken maxillary dental casts were required for inclusion (from canine to canine).

All the patient data identifying details were removed and a unique study code was assigned to each patient data.

Materials and Methods

An identification scenario for teeth was compared in the study. Maxillary dental casts and digital photos of 100 participants—50 male and 50 female—all of whom were orthodontic patients prior to receiving treatment were used for the data collection. Using a Medit t 500 extra oral scanner and the program Exocad (3D scans), maxillary dental casts were scanned to create an indirect 3D digital image. The data was stored in Stereolithography (STL) format, and these “3D cases” were exported to Adobe Photoshop 2014 CC software, where the following tooth measurements were taken: (Figure 1).

1. Mesiodistal incisal 1/3 (MD incisal third)
2. Mesiodistal middle 1/3 (MD middle third)
3. Labiopalatal incisal 1/3 (LP incisal third)
4. Crown length

These are the criteria used to measure each of the six teeth, and an excel file was copied with each measurement. The same patients’ digital photos were similarly taken, exported to Adobe Photoshop 2014 CC, and then resized (calibrated) using the width of the image set to one standard value of 5 centimetres. This allowed Photoshop to automatically adjust the height of the image to create a standard for digital images. The measurements were made using the same methodology as 3D models (Figure 2), and the information was copied into an Excel sheet. For a more thorough study, the patients’ 2D and 3D recovered data were compared.

The factors that will significantly discriminate based on gender have been identified using linear stepwise discriminant analysis. IBM SPSS version 24.0, the International Business Machines Corporation-Statistical Package for the Social Sciences, was the statistical program used for the statistical studies. The analysis will be descriptive. Using discriminant function analysis, gender estimation will be performed using

Table 2: Multivariate analysis of odontometric variables in males and females in 2D

VARIABLES	MALE			FEMALE			P VALUE
	Mean	Std. Deviation	CV%	Mean	Std. Deviation	CV%	
11 MD INCISAL THIRD	7.5080	2.01817	26.88	8.2380	2.33193	28.31	.097
11 MD MIDDLE THIRD	7.8660	2.00098	25.44	8.6060	2.29866	26.71	.089
11 LP INCISAL THIRD	1.3040	.45802	35.12	1.3520	.41317	30.56	.583
11 CROWN LENGTH	9.1740	2.25640	24.60	9.5800	2.64806	27.64	.411
12 MD INCISAL THIRD	5.9600	1.93338	32.44	6.4660	1.90955	29.53	.191
12 MD MIDDLE THIRD	6.7500	1.93129	28.61	6.8960	1.71511	24.87	.690
12 LP INCISAL THIRD	1.1020	.41231	37.41	1.2020	.47745	39.72	.265
12 CROWN LENGTH	8.1420	2.11178	25.94	8.4760	2.52979	29.85	.475
13 MD INCISAL THIRD	5.8720	2.05744	35.04	6.1460	2.05210	33.39	.507
13 MD MIDDLE THIRD	7.7600	2.05138	26.44	8.1760	2.06729	25.28	.315
13 LP INCISAL THIRD	1.5340	.39570	25.80	1.5900	.41020	25.80	.489
13 CROWN LENGTH	9.1760	2.70876	29.52	9.3120	2.70748	29.08	.802
21 MD INCISAL THIRD	7.4260	2.01634	27.15	8.1140	2.24181	27.63	.110
21 MD MIDDLE THIRD	7.7800	2.06111	26.49	8.2680	2.20171	26.63	.255
21 LP INCISAL THIRD	1.2020	.32166	26.76	1.2140	.31234	25.73	.850
21 CROWN LENGTH	8.2520	3.22808	39.12	8.7420	3.83247	43.84	.491
22 MD INCISAL THIRD	5.8520	1.92006	32.81	6.6100	2.22585	33.67	.071
22 MD MIDDLE THIRD	6.6520	1.83328	27.56	7.3100	1.93836	26.52	.084
22 LP INCISAL THIRD	1.0720	.40660	37.93	1.1120	.42697	38.40	.632
22 CROWN LENGTH	8.3820	2.43476	29.05	8.8480	2.48836	28.12	.346
23 MD INCISAL THIRD	5.9520	2.17643	36.57	6.3840	2.25826	35.37	.332
23 MD MIDDLE THIRD	7.8260	2.22865	28.48	8.1840	1.80287	22.03	.379
23 LP INCISAL THIRD	1.3860	.39590	28.56	1.4640	.41980	28.67	.342
23 CROWN LENGTH	9.3780	2.55800	27.28	9.5320	2.78109	29.18	.774

2D and 3D antemortem dental records. For every comparison, a P value of less than 0.05 will be deemed statistically significant. To create tables, Microsoft Word and Excel have been utilised.

Results

An observational multivariate discriminate analysis was done with 50 males and 50 females were undertaken to determine the significant odontometric variables for discriminating gender and also to evaluate the accuracy between 2D and 3D models.

The descriptive statistics, t-values, and p values of MD middle third, MD incisal third, LP incisal third and Crown length in males and females are depicted in Table -1. All maxillary anterior six teeth were included in the analysis. Results on continuous measurements are presented on mean+ or – standard deviation (SD) (Min-max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Statistically strongly significant values, with p<or- 0.01 was seen 11 crown length (p= .046), 13 MD middle third (p=.005), 13 crown length (p=.001), 23 MD middle third (p=.021), respectively.

The descriptive statistics, t-values, and p values of MD middle third, MD incisal third, LP incisal third and Crown length in males and females are depicted in Table -2. All maxillary anterior six teeth were included in the analysis. Results on continous measurements are presented on mean+ or – standard deviation (SD)(Min-max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Statistically strongly significant values, with p < or- 0.01 ware not seen in 2D, but 22 MD incisal third (p=0.071), 22 MD middle third (p=0.084), were statistically of suggestive of significance.

The tooth variables that contributed to the stepwise discriminant analysis for MD middle third, MD incisal third, LP incisal third, Crown length. Wilk's lambda denotes how useful a given variable is in the stepwise analysis and determines the order in which the variables enter the analysis. Crown length

Table 3: Stepwise discriminant function analysis (Mesiodistal, Buccopalatal, Crown length) in 3D

VARIABLES	Unstandard-ized coeffi-cients	Standard-ized coef-ficients	Sectioning points	Wilks' Lamb-da	P value	Percentage of correct clas-sification		
						Male	Female	Total
11 MD INCISAL THIRD	.306	.194	0.700 for Males -0.700 for Females	.667	0.040	76%	76%	76%
11 MD MIDDLE THIRD	.337	.212						
11 LP INCISAL THIRD	-.187	-.101						
11 CROWN LENGTH	.542	.289						
12 MD INCISAL THIRD	-.106	-.106						
12 MD MIDDLE THIRD	-.882	-.122						
12 LP INCISAL THIRD	.096	.015						
12 CROWN LENGTH	-.494	.095						
13 MD INCISAL THIRD	.119	.107						
13 MD MIDDLE THIRD	.187	.411						
13 LP INCISAL THIRD	-.187	.085						
13 CROWN LENGTH	.589	.471						
21 MD INCISAL THIRD	-.272	.096						
21 MD MIDDLE THIRD	.326	.094						
21 LP INCISAL THIRD	.378	.234						
21 CROWN LENGTH	-.302	.176						
22 MD INCISAL THIRD	-.225	-.105						
22 MD MIDDLE THIRD	.211	.044						
22 LP INCISAL THIRD	-.119	.087						
22 CROWN LENGTH	.557	.267						
23 MD INCISAL THIRD	.499	.099						
23 MD MIDDLE THIRD	.405	.334						
23 LP INCISAL THIRD	.118	.041						
23 CROWN LENGTH	-.547	.240						

of right maxillary canine entered the discriminant analysis first followed by MD middle third of right maxillary canine, MD middle third of left maxillary canine, Crown length of right maxillary central incisor, Crown length of left maxillary lateral incisor, Crown length of left maxillary canine, LP incisal third of left maxillary central incisor, MD middle third of right maxillary central incisor, MD incisal third of right maxillary central incisor, Crown length of left maxillary central incisor, MD incisal third of right maxillary canine, MD incisal third of left maxillary canine, MD incisal third of left maxillary central incisor, Crown length of right maxillary lateral incisor, MD middle third of left maxillary central incisor, LP incisal third of left maxillary lateral incisor, LP incisal third of right maxillary canine, MD middle third of left maxillary lateral incisor, LP incisal third of left maxillary canine, LP incisal third of right maxillary lateral incisor, LP incisal third of right maxillary central incisor, MD incisal third of left maxillary lateral incisor, MD incisal third of right maxillary lateral incisor, MD incisal third of right maxillary central incisor, MD incisal third of right maxillary lateral incisor, MD middle third of right maxillary lateral incisor. The standardizes coefficients are 0.471 for crown length 13, 0.411 for MD middle third of 13, 0.334 for MD middle third of 23, 0.289 for Crown length of 11, 0.267 for Crown length of 22, 0.240 for Crown length of 23, 0.234 for LP incisal third of 21, 0.212 for MD middle third of 11, 0.194 for MD incisal third of 11, 0.176 for Crown length of 21, 0.107 for MD incisal third of 13, 0.99 for MD incisal third of 23, 0.96 for MD incisal third of 21, 0.95 for Crown length of 12, 0.94 for MD middle third of 21, 0.87 for LP incisal third of 22, 0.85 for LP incisal third of 13, 0.44 for MD middle third of 22, 0.41 for LP incisal third of 23, 0.15 for LP incisal third of 12, -0.101 for LP incisal third of 11, -0.105 for MD incisal third of 22, -0.106 for MD incisal third of 12, -0.122 for MD middle third of 12. Sectioning point is 0.700 for males and -0.700 for females. Wilk's lambda is 0.667 with 76% predicted value for correct classification and is statistically significant (Table 3).

The tooth variables that contributed to the stepwise discriminant analysis for MD middle third, MD incisal third, LP incisal third, Crown length. Wilk's lambda denotes how useful a given variable is in the stepwise analysis and determines the order in which the variables enter the analysis. MD incisal third of left maxillary lateral incisor first enters in the discriminant

Table 4: Stepwise discriminant function analysis (Mesiodistal, Buccopalatal, Crown length) in 2D

VARIABLES	Unstandardized coefficients	Standardized coefficients	Sectioning points	Wilks' Lambda	P value	Percentage of correct classification		
						Male	Female	Total
11 MD INCISAL THIRD	.045	.297	-0.564 for Males 0.564 for Females	0.755	0.451	70%	72%	71%
11 MD MIDDLE THIRD	1.220	.304						
11 LP INCISAL THIRD	-.052	.098						
11 CROWN LENGTH	-1.754	.146						
12 MD INCISAL THIRD	.226	.233						
12 MD MIDDLE THIRD	-.249	.071						
12 LP INCISAL THIRD	.753	.199						
12 CROWN LENGTH	-.571	.127						
13 MD INCISAL THIRD	.224	.118						
13 MD MIDDLE THIRD	-.117	.179						
13 LP INCISAL THIRD	.227	.123						
13 CROWN LENGTH	-.482	.045						
21 MD INCISAL THIRD	1.365	.286						
21 MD MIDDLE THIRD	-1.548	.203						
21 LP INCISAL THIRD	-.483	.034						
21 CROWN LENGTH	1.716	.123						
22 MD INCISAL THIRD	1.207	.323						
22 MD MIDDLE THIRD	.641	.309						
22 LP INCISAL THIRD	-.779	.085						
22 CROWN LENGTH	.513	.168						
23 MD INCISAL THIRD	-.303	.173						
23 MD MIDDLE THIRD	-.364	.157						
23 LP INCISAL THIRD	.087	.169						
23 CROWN LENGTH	-.609	.051						

Table 5: Multivariate analysis of odontometric variables in males and females in 3D and 2D

Variable	Group	Mean	Std. Deviation	P value
11 MD INCISAL THIRD	3D	9.0140	.84447	.000*
	2D	7.8730	2.20045	
11 MD MIDDLE THIRD	3D	9.2660	.78666	.000*
	2D	8.2360	2.17606	
11 LP INCISAL THIRD	3D	2.0830	1.11265	.000*
	2D	1.3280	.43463	
11 CROWN LENGTH	3D	10.4770	1.30111	.000*
	2D	9.3770	2.45607	
12 MD INCISAL THIRD	3D	7.0900	1.24117	.000*
	2D	6.2130	1.92861	
12 MD MIDDLE THIRD	3D	7.8650	.94957	.000*
	2D	6.8230	1.81864	
12 LP INCISAL THIRD	3D	1.7120	.37987	.000*
	2D	1.1520	.44664	
12 CROWN LENGTH	3D	8.9490	1.21502	.016*
	2D	8.3090	2.32445	
13 MD INCISAL THIRD	3D	6.6850	1.53244	.009*
	2D	6.0090	2.04900	
13 MD MIDDLE THIRD	3D	8.3510	.83285	.086
	2D	7.9680	2.05956	
13 LP INCISAL THIRD	3D	2.3290	.41689	.000*
	2D	1.5620	.40196	
13 CROWN LENGTH	3D	9.5810	1.32670	.263
	2D	9.2440	2.69528	
21 MD INCISAL THIRD	3D	9.0380	.85774	.000*
	2D	7.7700	2.14925	
21 MD MIDDLE THIRD	3D	9.5000	.87721	.000*
	2D	8.0240	2.13589	
21 LP INCISAL THIRD	3D	1.9130	.37515	.000*
	2D	1.2080	.31549	
21 CROWN LENGTH	3D	10.3860	1.25296	.000*
	2D	8.4970	3.53383	
22 MD INCISAL THIRD	3D	7.0080	1.33141	.002*
	2D	6.2310	2.10285	
22 MD MIDDLE THIRD	3D	7.9370	1.00390	.000*
	2D	6.9810	1.90590	
22 LP INCISAL THIRD	3D	1.6220	.42345	.000*
	2D	1.0920	.41528	
22 CROWN LENGTH	3D	9.1070	1.30417	.079
	2D	8.6150	2.46041	
23 MD INCISAL THIRD	3D	6.6540	1.52332	.072
	2D	6.1680	2.21715	
23 MD MIDDLE THIRD	3D	8.4650	.77295	.035*
	2D	8.0050	2.02471	
23 LP INCISAL THIRD	3D	2.1560	.41202	.000*
	2D	1.4250	.40785	
23 CROWN LENGTH	3D	9.6790	1.35254	.454
	2D	9.4550	2.65947	

analysis followed by MD middle third of left maxillary lateral incisor, MD middle third of right maxillary central incisor, MD incisal third of right maxillary central incisor, MD incisal third of left maxillary central incisor, MD incisal third of right maxillary lateral incisor, MD middle third of left maxillary central incisor, LP incisal third of right maxillary lateral incisor, MD middle third of right maxillary canine, MD incisal third of left maxillary canine, LP incisal third of left maxillary canine, Crown length of left maxillary lateral incisor, MD middle third of left maxillary canine, Crown length of right maxillary central incisor, Crown length of right maxillary lateral incisor, LP incisal third of right maxillary canine, Crown length of left maxillary central incisor, MD incisal third of right maxillary canine, LP incisal third of right maxillary central incisor, LP incisal third of left maxillary lateral incisor, MD middle third of right maxillary lateral incisor, Crown length of left maxillary canine, Crown length of right maxillary canine, LP incisal third of left maxillary central incisor (Table 4).

The standardized coefficients are 0.323 for MD incisal third of 22, 0.309 for MD middle third of 22, 0.304 for MD middle third of 11, 0.297 for MD incisal third of 11, 0.286 for MD incisal third of 21, 0.233 for MD incisal third of 12, 0.203 for MD middle third of 21, 0.199 FOR LP incisal third of 12, 0.179 for MD incisal third of 13, 0.173 for MD incisal third of 23, 0.169 for LP incisal third of 23, 0.168 for Crown length of 22, 0.157 for MD middle third of 23, 0.146 for Crown length of 11, 0.127 for Crown length of 12, 0.123 for LP incisal third of 13. Sectioning point is -0.564 for males and 0.564 for females. Wilk's lambda is 0.755 with 71% predicted value for correct classification and is statistically significant.

The significant gender estimating showing all the parameters in comparing both 3D and 2D except some teeth 23 Crown length (P = 0.454), 23 MD incisal third (P= 0.072), 22 Crown length (P= 0.079), 13 Crown length (P= 0.263), 13 MD middle third (P= 0.086) (Table 5).

Discussion

Anthropologists, biologists, palaeontologists, and orthodontists have all been interested in the study of teeth. This is due to the fact that teeth are typically still present long after bone structures have been damaged. Measurements of linear dimensions, such anthropometric and odontometric traits, can be used to detect gender in large populations despite the accuracy of the DNA profile since they are easy to take, dependable, inexpensive, and uncomplicated. A large body of study has been done on the human dentition, most of it focussing on the morphology, odontometric variation, and oral health of humans. Teeth have been used forensically to determine age and gender most of the time. The first technique for identifying gender is based on analysing the relative proportions or visual form of traits that are gender dimorphic.

The second method is a metric approach, which is superior to the visual technique because it is more objective in general, more reliable, less dependent on the experience of previous observers, and more accessible to statistical analysis. It so makes comparisons easier, both between samples and with previous research. The two most widely used and studied characteristics in the estimation of gender based on dental measures are the MD and LP diameters of permanent teeth. Stepwise discriminant function analysis, which finds the optimal mix of components and weights them according to how much of a contribution they make to gender estimating, forms the basis of most odontometric gender estimating.

When integrating craniofacial and odontometric data, the estimation effectiveness increased from 55.8% (craniofacial features alone) to 86% (combining both features), which was almost identical to the findings of the Gowri vijay reesu et al. study.[9] In this work, we selected four tooth diameters (MD middle third, MD incisal third, LP incisal third, and crown length) and compared them using two methods (3D and 2D) in order to determine the gender of an unknown subject and to determine

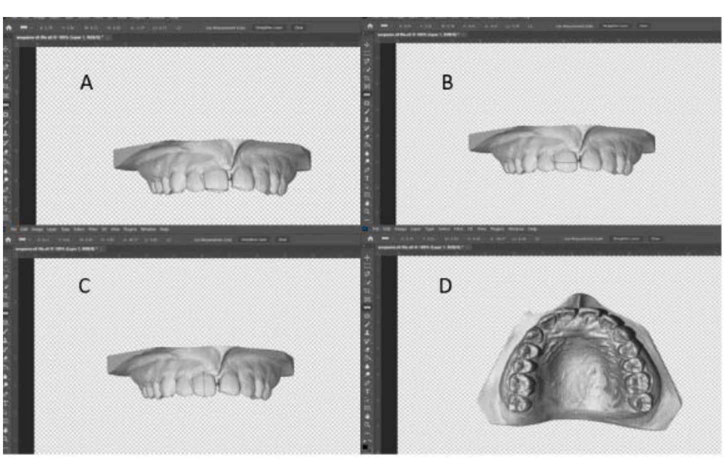

Fig. 1: shows Measurement of mesiodistal incisal third, middle third, crown length, labio palatal length of 11 in 3D.

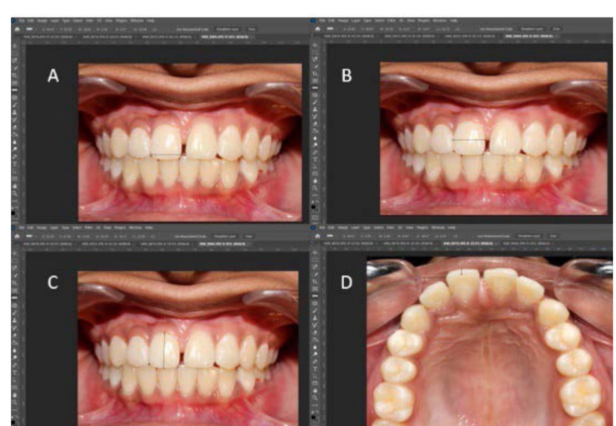

Fig.2: shows Measurement of mesiodistal incisal third, middle third, crown length, labio palatal length of 11 in 2D.

a more precise method for comparing antemortem models in identification scenarios (Dental Gender dimorphism).

Due to their greater visibility, we have selected both 3D and 2D approaches, but we have only taken into account the maxillary anterior teeth. The 2D method for comparison with 3D was taken into consideration because, in this day and age, when smart phone usage is on the rise and digitalised photographs play a vital role in which the incisors would be prominently seen (incisal surfaces of the anterior teeth have uniqueness) (Kieser et al. 2007).[13]

The teeth diameters in fragmented and badly preserved skeletal remains can be successfully utilised to estimate gender, as demonstrated by Ditch and Rose. This is comparable to our study, which employed two methodologies (3D and 2D) to estimate gender using the odontometric method.

All the four variables included into the present study are not statistically significant except, with $p <$ or -0.01 was seen 11 crown length ($p = .046$), 13 MD middle third ($p = .005$), 13 crown length ($p = .001$), 23 MD middle third ($p = .021$), these are statistically strongly significant values in 3D technique, but in 2D technique all the four variables are not statistically significant for the gender estimating. The current study's findings supported those of earlier research by Garn et al.[14] and Acharya et al.[15], which found that the canines and central incisors had the greatest levels of gender-dimorphism.[16]

In contrast to a study by Litha et al., which found that BL dimensions were more significant than the tooth's MD dimensions, our investigation found that crown length and MD dimensions were more significant than BL dimensions. Comparing the MD and BL measures, Ayesha Shireen et al. found that the dimensions of posterior teeth display larger sexual dimorphism than the dimensions of BL teeth, however our study found that the anterior teeth exhibit greater genderual dimorphism in the MD and crown length measurements.

The right and left maxillary canines in a study by Khagura et al. displayed the highest genderual dimorphism; this was also the case for both maxillary canines in our investigation.[17] According to Işcan and Kedici (2003), our study's MD dimensions are more significant than LP for anterior teeth in gender estimating, however Iscan and Kedici et al.'s study found that BL dimension is a more reliable measurement than MD for posterior teeth in gender estimating.[18]

While Kapila R et al. and Kaushal S et al.'s work shown that mandibular canine linear measurement can be utilised to gender a population, our study found that maxillary canines produced more accurate gendering results.19 This study showed that 3D AM technology was superior to 2D AM technology for dental comparison. We obtained 76% accuracy for 3D technology and 71% accuracy for 2D technology. The results were similar to those of a study conducted by Gowri Vijay Reesu et al., but they employed the 2D-3D superimposition technique.

Conclusions

1. Significant dimorphic differences between male and female teeth with males exhibiting larger teeth than females.
2. MD and crown length shows greater accuracy in gender estimating when compared to LP variables.
3. 3D technique is more efficient and accurate for gender estimating than 2D technique

The findings of this study confirm the findings of numerous earlier studies showing male tooth dimensions are statistically greater than those of females. With 76 percent (3D) and 71 percent (2D) accuracy, stepwise discriminant function analysis were found to have a very good ability to distinguish between gender in the population. As a result, gender analysis based on tooth dimensions has never been viewed as the primary means of gender discrimination, but rather as a complement. More sample size recording of similar observations will enable the independent application of each form of linear measurement in odontometric gender distinction. When it comes to storing patient data in the form of 3D models for stranger identification, this documentation will be extremely helpful.

References

1. Anas IY, Bamgbose BO, Nuhu S. A comparison between 2D and 3D methods of quantifying facial morphology. Heliyon [Internet]. 2019;5(6):e01880.
2. Shireen A, Ara SA. Odontometric analysis of permanent maxillary first molar in gender determination. Journal of forensic dental sciences. 2016 Sep 1;8(3):145-9.
3. Bharath TS, Saraswathi TR, Suresh Sajjan MC, Ramchandran CR, Govindraj Kumar N. Isolation and quantification of DNA from epithelial cells obtained from acrylic removable partial denture for sex identification. Egyptian Journal of Forensic Sciences. 2019 Dec;9:1-8.
4. Babu GS, Bharath TS, Kumar NG. Characteristics of palatal rugae patterns in west godavari population of India. J Clin Diagn Res [Internet]. 2013;7(10):2356–9.
5. Shetty SJ, Ratnaparkhi I, Pereira T, Acharya S, Gotmare S, Kamath P. Odontometric analysis of canines to establish sexual dimorphism in an urban population. Indian Journal of Dental Research. 2019 Nov 1;30(6):855-9.
6. Girish HC, Murgod S, Savita JK. Gender determination by odontometric method. Journal of forensic dental sciences. 2017 Jan 1;9(1):63-70.
7. Devi A, Gupta S, Kamboj M, Narwal A, Kumar V, Raman R. Determination of Sexual Dimorphism by Odontometric Study of Permanent Maxillary Incisors and Canines: A Cross-sectional Study from Population of Haryana. Journal of Clinical & Diagnostic Research. 2021 Oct 1;15(10).
8. Rani ST. Applicability of odontometric dimensions and indices in sexual dimorphism among Nalgonda population. Journal of forensic dental sciences. 2017 Sep 1;9(3):175.
9. Reesu GV, Mânica S, Revie GF, Brown NL, Mossey PA. Forensic dental identification using two-dimensional photographs of a smile and three-dimensional dental models: A 2D-3D superimposition method. Forensic Sci Int. 2020;313(110361):110361.
10. Khanna S. Exploring the 3rd dimension: Application of 3D printing in forensic odontology. J Forensic Sci Crim Investig. 2017;3(4).
11. Sheets HD, Bush PJ, Bush MA. Patterns of variation and match rates of the anterior biting dentition: characteristics of a database of 3D-scanned dentitions. J Forensic Sci. 2013;58(1):60–8.
12. Blackwell SA, Taylor RV, Gordon I, Ogleby CL, Tanijiri T, Yoshino M, et al. 3-D imaging and quantitative comparison of

human dentitions and simulated bite marks. Int J Legal Med. 2007;121(1):9–17.

13. Kieser JA, Bernal V, Neil Waddell J, Raju S. The uniqueness of the human anterior dentition: a geometric morphometric analysis. J Forensic Sci. 2007;52(3):671–7.
14. Garn SM, Lewis AB, Swindler DR, Kerewsky RS. Genetic control of sexual dimorphism in tooth size. J Dent Res. 1967;46(5):963–72.
15. Acharya AB, Mainali S. Univariate sex dimorphism in the Nepalese dentition and the use of discriminant functions in gender assessment. Forensic Sci Int. 2007;173(1):47–56.
16. Dumpala RK, Guttikonda VR, Madala J, Kanth S. Sex determination using diagonal measurement of teeth in a tribal and an urban population: a comparative study. Int J Cont Med Res. 2014;1(2):27-33.
17. Khangura RK, Sircar K, Singh S, Rastogi V. Sex determination using mesiodistal dimension of permanent maxillary incisors and canines. Journal of forensic dental sciences. 2011 Jul;3(2):81.
18. İşcan MY, Kedici PS. Sexual variation in bucco-lingual dimensions in Turkish dentition. Forensic science international. 2003 Nov 26;137(2-3):160-4.
19. Kapila R, Nagesh KS, Iyengar AR, Mehkri S. Sexual dimorphism in human mandibular canines: a radiomorphometric study in South Indian population. Journal of dental research, dental clinics, dental prospects. 2011;5(2):51.