ORIGINAL RESEARCH

Radiographic study of Mental Foramen characteristics and its relation with gender among the South Indian adult population

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Abstract

Introduction: Forensic odontology examines jurisdictional concerns, victim identification in major disasters using dental records to analyze the skeletonized or severely decomposed individuals. The mental foramen (MF) located on mandible is regarded as a reliable marker on the mandible that can be utilized to determine sex.

Aim & Objectives: The goal of the current study was to evaluate the differences in type, shape, and position of mental foramen in a selected South Indian population in order to ascertain the reliability of MF as a tool to assess sexual dimorphism.

Materials and Methods: A retrospective study was done on 232 OPG's (128 males, 104 females) in the age group between 20 and 40 years after taking approval from Institutional Ethical Committee. All OPGs were captured by a single radiology technician.

Results: Of all the left and right mental foramen analyzed in male & female subjects based on Jasser-Nwoku criteria, Position IV of MF was found to be predominant followed by Position III and V. Based on Yosue and Brooks criteria MF type I was predominant in males

Conclusion: Type I continuous was the most prevalent appearance of the MF on panoramic radiographs. On both the left and right sides, the MF was most frequently rounded in both genders. Among both males & females on both the left and right sides, the most common position of the mental foramen was in line with the second premolar.

Keywords: Mental Foramen, type, shape, and position of MF, Al Jasser-Nwoku and Yosue-Brooks methods.

Introduction

An interdisciplinary field of study called forensic odontology examines jurisdictional concerns, victim identification in major disasters, and the use of dental records to analyze natural disasters. When forensic identification of skeletonized or severely decomposed unknown individuals is being done, gender identification is the first step in the identification process for adult skeletons, which is an essential part of biological profile estimation. In the past, the most researched part of the skeleton for variations related to gender has been the skull. The mandible is one of the many anatomical markers in the human skull. It is the largest, thickest, and strongest bone in the face, making it the most resilient and best preserved bone for personnel identification in major disasters. The mental foramen (MF) is regarded by anthropologists and forensic dentistry as a reliable marker on the mandible that can be utilized to determine sex. On the outside of the jaw, around the mandibular premolars, lies the buccal bilateral opening of the mandibular canal.[1]

In addition to being useful tools, radiographs support forensic investigations. One easy, non-invasive, affordable, and trustworthy way to find the unidentified gender is to interpret OPGs. When seen on a radiograph, MF is seen as a tiny, radiolucent, ovoid or spherical patch in the mandibular premolars' apical region. Throughout life, the distance between the lower border of the mandible and the inferior border of the MF is relatively consistent.[2]

The goal of the current study was to compare the results obtained from 200 digital panoramic radiographs taken of

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the West Godavari population with those obtained from other populations in order to ascertain the most common position of the mental foramen and to estimate differences in type, shape, and position of mental foramen based on gender in a selected South Indian population. This is one of the first studies of its sort that looked at the sex of a person based on where their mental foramen was located using digital OPGs in the West Godavari community.

The aim of the study was to assess sexual dimorphism in a randomly selected population by utilizing MF as a landmark on OPGs, according to al Jasser-Nwoku and Yosue-Brooks methodologies.

Methodology

A retrospective study was done on 232 OPG's (128 males, 104 females) in the age group between 20 and 40 years undergoing conventional OPG for diagnostic, periodontal, surgical, or orthodontic purposes at the Department of Oral Medicine, Radiology and Oral Pathology, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India. All OPGs were captured by a single radiology technician using Xtropan 2000 system (tube potential: 50–85 KV, tube current: 12 mA, and time: 14 s) using Carestream (TMat GIRA) films. The magnification factor reported by the manufacturer was 1.2. Ethical approval was obtained by Institutional Ethical Committee bearing the number IECVDC/24/F/OP/IVT/121 and informed consent statemnts were taken.

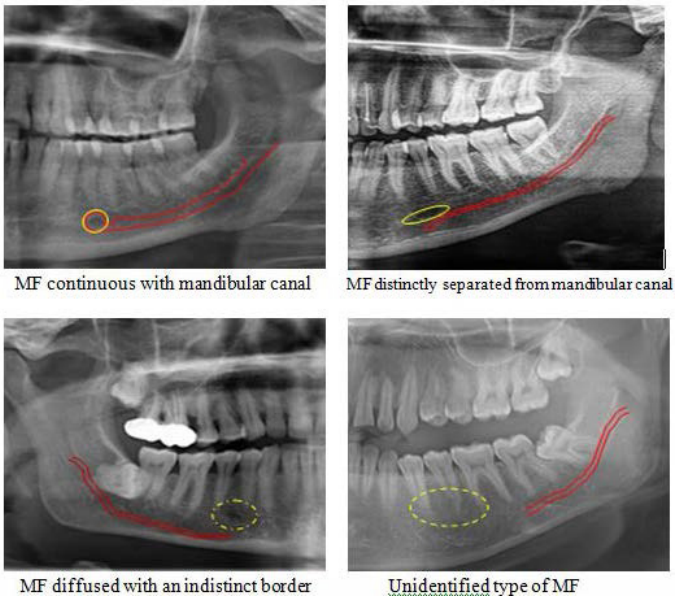

Fig. 1 showing types of Mental Foramen according to Yosue and Brooks Criteria[4]

Source of the data

Conventional OPG taken for diagnostic, periodontal, surgical or orthodontic purposes at the Department of Oral Medicine, Radiology and Oral Pathology, West Godavari District, Andhra Pradesh, India.

Selection criteria

Inclusion criteria were: Male and female patient radiographs with age group of 21-40 years without any pathologies and radiographs with adequate density, contrast and clarity were included in the study. Exclusion criteria were: radiographs with blurred images and artifacts caused by metallic objects, not covering entire mandibular and any associated pathologies were excluded from the study. Diffuse, unidentified MF appearance on the OPG was excluded from the study.[3]

Sample size calculation: Using the G power 3.1 software, sample size was calculated based on a desired power of 0.80, an alpha level of 0.05, and an accuracy of mandibular ramus and maxillary sinus for determination of sex was 84% and 90%. The estimated sample size was 200.

Procedure

The Type of MF was classified based on Yosue and Brooks classification as follows (Figure 1&2):[3,4]

- Type I: Mental canal is continuous with the mandibular canal
- Type II: Foramen is distinctly separated from the mandibular canal
- Type III: Diffuse with a distinct border of the foramen

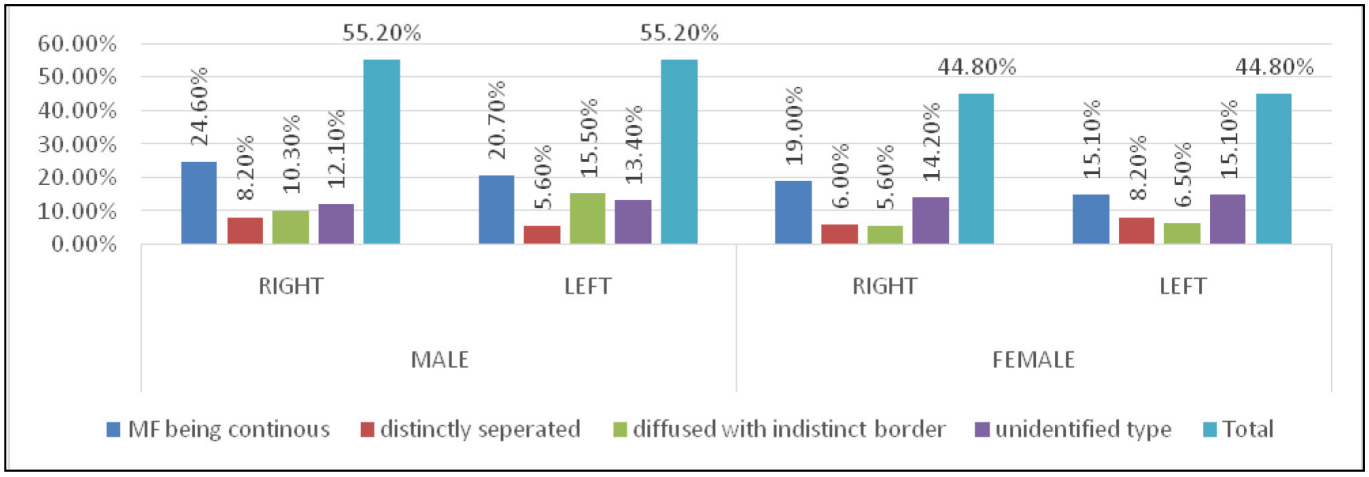

Fig. 2 shows Type of MF in males and females on each side

•Type IV: Unidentified type, in which the MF cannot be identified on panoramic radiographs under ordinary exposure and viewing conditions.

The Position of MF was classified based on The al Jasser-Nwoku method as follows (Figure 3&4):[3,5]

•Position 1: Anterior to first premolar
•Position 2: In line with first premolar
•Position 3: Between first and second premolar
•Position 4: In line with second premolar
•Position 5: Between second premolar and first molar
•Position 6: In line with first molar.

Statistical analysis

The collected data was entered in Microsoft excel spread sheet and Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software version 26 (USA: IBM. Corporation). Pearson's Chi Square test was applied to see the significant differences; P < 0.05 was considered statistically significant. Discriminate functional analysis was used to assess the type, shape and position of mental foramen for gender determination with a 0.05 or lower p-value was found to be statistically significant.

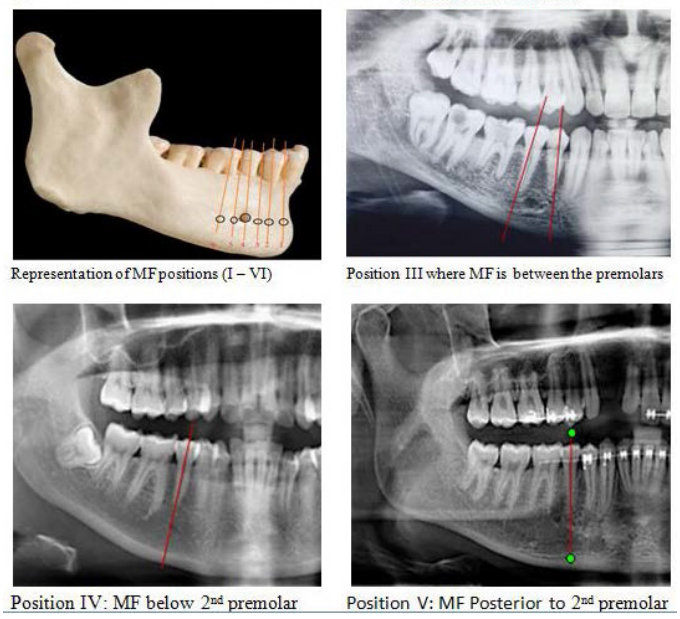

Fig. 3 showing position of the mental foramen according to Jasser And Nwoku Criteria[5]

Results

Out of 232 panoramic radiographs, 128 were of male patients and 104 were of female patients. Total 464 mental foramen were studied accounting for the left and right mental foramen. On examination, MFs exhibited a predominantly round shape (left: 34.9% and right: 40.5%) followed by oval (left: 8.6% and right: 8.6%) in both males and females and in different age groups. Undetermined shape of MF was noticed oval (left: 25.4% and right: 22%) (Table 1a, 1b) (Figure 5).

Assessment of MF Type based on Yosue and Brooks criteria in males

The assessment of Yosue and Brooks criteria on right MF showed that the most common type was Type I in males (24.6%) followed by Type IV, III and II (12.1%, 10.3% and 8.2%) respectively. The same criteria on left MF showed that the most common type was Type I in males 20.7% followed by III followed by IV and II (15.5%, 13.4% and 5.6%) respectively. (Tables 2a, 2b).

Assessment of MF Type based on Yosue and Brooks criteria in females

The assessment of Yosue and Brooks criteria on right MF showed that the most common type was Type I in females

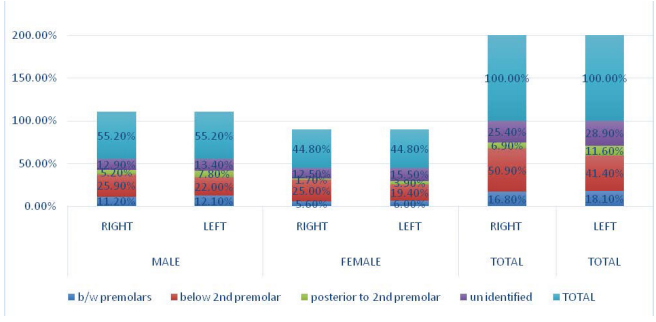

Fig. 4 shows Position of MF in males and females on each side

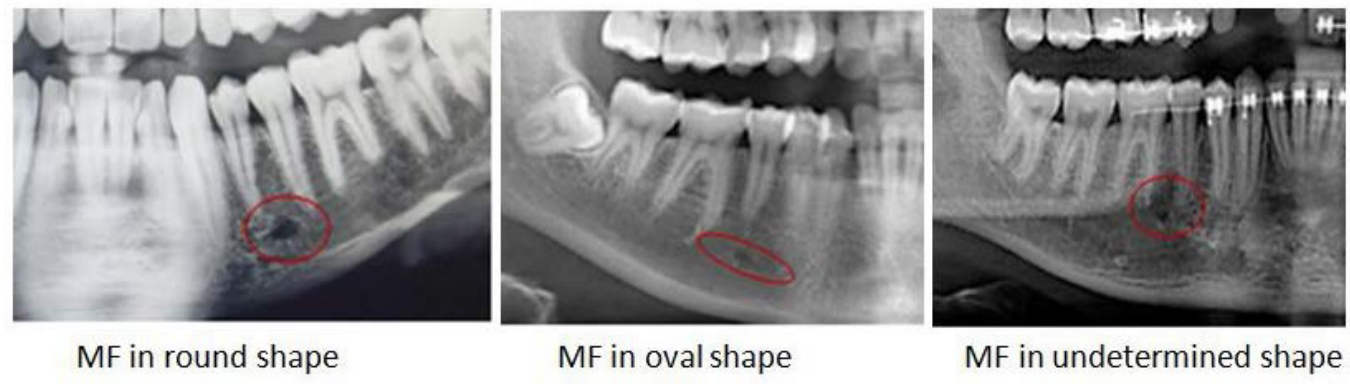

Fig. 5 showing shapes of the mental foramen

(19%) followed by Type IV, II and III(14.2%, 6.0% and 5.6%) respectively. The same criteria on left MF showed that the most common type was Type I in females 20.7% followed by III followed by IV and II(15.1%,8.2%and 6.5%) respectively (Tables 2a, 2b).

Assessment of MF Position based on Jasser-Nwoku criteria in males

Of all the left mental foramen analyzed in male subjects, 22% were located below the second premolar (Position IV), followed by Position III and V with 12% and 7.8% respectively. The right foramen also followed the same pattern with 25.9%, 11.2% and 5.2% respectively. (Tables 3a, 3b).

Assessment of MF Position based on Jasser-Nwoku criteria in females

Of all the left mental foramen analyzed in female subjects, 19.4% were located below the second premolar (Position IV), followed by Position III and V with 06% and 3.9% respectively. The right foramen also followed the same pattern with 25.0%,

Tab 1.a shape of MF on Right side in males and females

		SHAPE ON RIGHT SIDE						
		Round	Oval	Un-deter Mned	Can-not ac-cess	To-tal	Chi-squar e	P-val-ue
MALE	Count	56	11	26	35	128	1.332a	0.721
	%	24.1%	4.7%	11.2%	15.1%			
FEMA LE	Count	38	9	25	32	104		
	%	16.4%	3.9%	10.8%	13.8%			
Total	Count	94	20	51	67	232		
	%	40.5%	8.6%	22.0%	28.9%			

Tab 1.b shape of MF on Left side in males and females

		SHAPE ON LEFT SIDE						
		Round	Oval	Un-deter mned	Can-not access	Total	Chi-squar e	P-value
MALE	Count	51	13	31	33	128	5.473a	0.140
	%	22.0%	5.6%	13.4%	14.2%			
FEMA LE	Count	30	7	28	39	104		
	%	12.9%	3.0%	12.1%	16.8%			
Total	Count		20	59	72	232		
	%		8.6%	25.4%	31.0%			

Tab2.a Type determination by Yosue and Brooks Criteria on Right side in males and females

		RIGHT SIDE				Total	Chi-square	P-valu e
		Mf being contin-uous	Dis-tinctly sepa-rated	dif-fused	Un-identi-fied type			
MALE	Count	57	19	24	28	128	3.667a	0.030
	%	24.6%	8.2%	10.3%	12.1%			
FE-MAL E	Count	44	14	13	33	104		
	%	19.0%	6.0%	5.6%	14.2%			
Total	Count	101	33	37	61	232		
	%	43.5%	14.2%	15.9%	26.3%			

Tab2.bType determination by Yosue and Brooks Criteria on Left side in males and females

		LEFT SIDE						
		MF being contin-uous	Dis-tinctly sepa-rated	Dif-fused	Un-identi-fied type	Total	Chi-Square	p-Valu e
MALE	Count	48	13	36	31	128	9.671a	0.022
	%	20.7%	5.6%	15.5%	13.4%			
F E - MAL E	Count	35	19	15	35	104		
	%	15.1%	8.2%	6.5%	15.1%			
Total	Count		32	51	66	232		
	%		13.8%	22.0%	28.4%			

Tab.3.a Position of MF on Right side of males and females by Jasser and Nwoku Criteria

		LOCATION ON RIGHT SIDE						
		Be-tween premo-lars	Below 2nd premo-lar	Pos-terior to 2nd premo-lar	un-identi-fie d	Total	Chi-Squar e	p-Value
MALE	Count	26	60	12	30	128	5.965a	0.113
	%	11.2%	25.9%	5.2%	12.9%			
FEMA LE	Count	13	58	4	29	104		
	%	5.6%	25.0%	1.7%	12.5%			
Total	Count	39	118	16	59	232		
	%	16.8%	50.9%	6.9%	25.4%			

Tab.3.b Position of MF on Left side of males and females by Jasser and Nwoku Criteria

		LOCATION ON LEFT SIDE						
		Be-tween pre-molars	Below 2nd pre-molar	pos-terior to 2nd pre-molar	Un-identi-fie d	Total	Chi-Squar e	p-Value
MALE	Count	28	51	18	31	128	5.996	0.112
	%	12.1%	22.0%	7.8%	13.4%			
FEMA LE	Count	14	45	9	36	104		
	%	6.0%	19.4%	3.9%	15.5%			
Total	Count		96	27	67	232		
	%		41.4%	11.6%	28.9%			

5.6% and 1.7% respectively. (Tables 3a, 3b).

Discussion

Mental foramen is considered an imperative anatomical landmark, which assists surgical, local anesthetic and other invasive procedures for maxillofacial surgeries. Location and direction of the mental foramen are crucial for maintaining the integrity of the mental nerve trunk during surgical procedures as mental nerve injury can result in either permanent or temporary changes to sensitive, tactile, and thermal perception. Sometimes a radiolucent lesion located in the apical region of the mandibular premolar teeth is mistakenly identified as the mental foramen. According to studies by Wical and Swoope in 1974[6], Lindh et al in 1995[7], and Güler et al in 2005[8] resorption of the alveolar process above the foramen has little effect on the stability and position of the mental foramen. The position and shape of MF can facilitate Age estimation and skeletal remains identification. Knowledge on the anatomy of jaw including the mental foramen would be of great advantage in bite marks analysis.[2]

Forensic identification can make use of the co-relation of dental records using MF location using panoramic radiography which has an advantage of a larger view of the maxillary facial skeleton and the mental foramina can be localized more precisely compared to periapical radiographs which may not be able to reveal the position of the MF if it is below the film's edge. Hence OPG was used in this study to compare the right and left foramen. The location of the mental foramen can vary widely. MF is positioned differently depending on the gender, as multiple studies have shown.[2,3]

Out of 464 MF that were evaluated for shape the round shape of MF was most common in our study bilaterally among males and females (40.5% and 34.9% on the left and right sides, respectively), followed by oval and in determinate shapes, on both the right and left sides. The results did not align with the observations made by Gershen son and colleagues[9], Sheikhi and Kheir[10], Prabodha and Nanayakkara[11].

According to the Jasser-Nwoku criteria, the most common location of mental foramen on both the left and right sides, for both genders, was in continuity with the second premolar in both sides (%), followed by the position of mental foramen between the first and second premolar (%) in the current study, which was conducted among the population of West Godavari, a region in South India. Mental foramen between the second premolar and first molar (%) came next.

These results were consistent with research conducted by Patel et al. (2015)[13] in the Sa urashtra population, Udhaya et al. (2013)[14] in the South Indian population, Singh and Srivastav (2017)[15] in Lucknow, Uttar Pradesh, and Shankland[16] in the Asian Indian population all produced findings that were similar.

Numerous investigations have been carried throughout various Indian states revealed variances in the status of M F. Research by Babshet[17] among people in Dharwad, Karnataka; Gada and Nagda[18] in Mumbai; Moogala et al[19] among people in Andhra; and Jamdade et al 20 among people in Rajasthan revealed the most common location of the mental foramen between the first and second premolars. Distinct populations and ethical groups are associated with distinct positions of the mental foramen. Muscle forces, nutrition or eating habits, neuro-cranium size and shape, head position, facial biotype, tooth size, environmental and socioeconomic factors, racial features, mandibular morphology and masticatory function are other factors that can affect position.[2]

According to Youse and Brookes criteria[4], Type I (continuous with mandibular canal) mental foramens are the most common kind in the current study. On the right side for the male population, Type II, Type III, and Type IV come next. Conversely, Type I was more prevalent on the left side, followed by Type II, III, and IV.

Similar to this, Type I (continuous with mandibular canal) mental foramens are most common in females, while on the right side are Type IV, Type II, and Type III. Conversely, Type I was more prevalent on the left, followed by Type III, Type IV, and Type II, which is consistent with the distribution of the type in the male population.

The discrepancy in these results can be explained by the fact that androgens and estrogen, which are sexual hormones, play a role in the formation of morphologic differences in the skeletons of the face and cranium between the genders as well as in the varying rates at which these differences manifest in later adulthood.[2]

Enlow (1982) noted that adult women's bone growth is slower than that of men's, and added that local elements like bite force and masticatory muscles are crucial in the development of the craniofacial skeleton. Men have more bone deposition around the bottom edge of the jaw than women do because men typically have stronger muscles and a greater bite force. The use of panoramic radiographs to locate mental foramen rather than starting an anatomical investigation on skulls was a limitation of the current study[2].

Olasoji et al[21] however, examined mental foramen in adult northern Nigerians using randomized skulls and panoramic radiographs and found no discernible variation between the two techniques for detecting the mental foramen[21].

The results of this study showed that there are notable differences between genders in type and location of mental foramen. MF can be a reliable measure of gender determination across different racial and ethnic groups among different populations. This procedure becomes especially significant aid for gender identity during huge disasters where only portions of jaws are recovered.

Conclusion

The current investigation has led to the following conclusions:

- Type I continuous was the most prevalent appearance of the MF on panoramic radiographs; it was followed by Type III diffuse, Type IV unknown type, and Type II separate type on the left side.
- On panoramic radiographs, Type I continuous MFs were most frequently seen, followed by Type IV MFs that were unknown, Type III MFs that were diffuse for men, and Type II MFs that were distinct fo r women on the right side.

- On both the left and right sides, the MF was most frequently rounded in both genders.
- In both males & females on both the left and right sides, the most common position of the mental foramen was in line with the second premolar, followed by the position between the first and second premolar and finally, the position between the second premolar and the first molar.
- Gender differences existed in the position of the mental foramen. Therefore, it is clinically significant to comprehend the significance of structural changes of the mental foramen and to locate it during preoperative radiologic al tests.
- Furthermore, resorption of the alveolar process above the foramen does not influence the stability of the placement of the mental foramen with respect to gender, which enables its applicability in forensic gender identification.
- MMF is a vital technique in forensic investigations involving dental and skeletal evidence since it helps with identification, age estimation, gender determination, and trauma analysis. It is a crucial milestone in forensic odontology studies.

Ethical approval

The study was approved by the Institutional Review Board of Vishnu Dental College and ethical clearance was obtained from the institutional ethics committee bearing the number IECVDC/24/F/OP/IVT/121.

Informed consent

Informed consent was waived by the Institutional Review Board of Vishnu Dental College, as the archived radiographs were collected for analysis. This is in accordance with the criteria for exemption from the Investigational Device Exemptions regulation at 21 CFR 812.2 (c) (3).

Authors' contributions

GK is the primary investigator. GK, RM and KVC were involved in all aspects of the experimental design, data collection, and data analysis and were the primary contributors to manuscript preparation. GK and SP performed the tooth reconstruction. RM, ANS, and SB performed the evaluation and comparison of natural and reconstructed teeth parameters. GK and SP were involved in manuscript preparation and study design. All authors read and approved the final manuscript.

Availability of data and materials

The Further data and information are not publicly available because other, currently unpublished studies are based on it, but are available from the corresponding author on reasonable request.

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