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Mandibular canine index and pont's index to establish sex identity in Sriganganagar population

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Abstract
Introduction: Odontometric parameters are acknowledged as essential instruments in forensic identification, especially in catastrophic disasters where only dismembered remains are present. The mandibular canine index (MCI) and Pont's index are commonly utilized for sex determination because to their established sexual dimorphism across several groups. The present study aimed to evaluate the accuracy of MCI and Pont's index in establishing sex identity in the Sri Ganganagar population.
Material and methods: A study was performed *in vivo* involving 100 participants (50 males and 50 females) aged 18 to 25 years, chosen according to defined inclusion and exclusion criteria. Measurements of mesio-distal canine width, inter-canine distance, premolar and molar arch widths, and combined incisor widths were obtained with a digital vernier caliper. The MCI, premolar index, and molar index were computed, and statistical analysis was conducted utilizing SPSS version 25.0, with significance established at $p<0.05$.
Results: Males demonstrated considerably larger mesio-distal canine widths, inter-canine distances, premolar widths, and molar widths than females ($p<0.05$). The average mandibular canine distance was 25.61±0.69 mm in males and 25.00±0.31 mm in females. The observed MCI values for the right and left sides were 22.88±2.11 and 22.98±2.32 for males, and 20.00±0.44 and 20.00±0.12 for females, respectively. The precision of gender prediction with MCI varied from 65% to 76%, demonstrating superior predictability in females and on the right side. Pont's premolar and molar indices exhibited reduced predictive accuracy (57-69%) relative to MCI.
Conclusion: MCI was more accurate for sex determination in Sri Ganganagar than Pont's index, which showed sexual dimorphism. These indices are simple, cost-effective, and fast for forensic applications, but their predictive accuracy is below 85%, requiring caution and validation using additional methods. To build meaningful population-specific criteria, more and more diverse samples are needed.

Keywords: Forensic odontology, mandibular canine index, odontometry, pont's index, sexual dimorphism

Introduction

In the modern era, odontometrics has become a crucial tool in the investigation of high-speed accidents, social violence, aeroplane crashes where bodies are severely mutilated, & criminal acts. In particular, when bodies are damaged or mutilated & only pieces of jaw bones with teeth are found, odontometrics plays a significant role in determining sex, which is regrettably very common in our nation [1, 2].

Since no two mouths are alike, sexual dimorphism refers to the differences in size, stature, & look between males & females that can be used to aid in a person's dental identification. Some skeleton measurements are typically sufficient for sex identification since, although DNA tests have been developed in recent years that provide reliable sex determination, they are costly, time-consuming, & a tiresome task [3].

For anthropological, genetic, odontologic, & forensic research, teeth provide a good material since they are the strongest, hardest, & most chemically stable tissue in the human body. They also show the least turnover of natural structure among all the tissues [4]. As the most durable mineralised tissues in the human body, teeth are useful for forensic inquiry & study because they can withstand mechanical, thermal, chemical, & physical damage—even from fire &

bacterial decomposition. employing odontometric analysis, which uses a vernier calliper to assess the tooth's metric properties, including mesiodistal, buccolingual, & arch width [5].

The Canine Index is a straightforward odontometric technique that detects gender dimorphism by using mandibular canines. The ratio of the intercanine arch width to the mandibular canine mesiodistal diameter is known as the canine index. By comparing the observed MCI with the standard MCI value, studies on the lower canine using the mandibular canine index (MCI), which is the ratio of mandibular crown width to intercanine width, have demonstrated the ability to determine gender with an accuracy of up to 83.3% in males & 81% in females [6, 7].

Anthropologists & odontologists have examined gender differences in tooth size, concentrating on the buccolingual & mesiodistal dimensions of teeth. It is well recognised that gender-dimorphic dimensions are only meaningful when compared to a population. This study aims to close the gap in the literature by determining gender among the Sri Ganganagar population using the linear measurements (MCI & Pont's index) of the maxillary & mandibular teeth.

Material and Methods

The present *in vivo* study was undertaken in the Department of Oral & Maxillofacial Pathology, Surendra Dental College & Research Centre, Sri Ganganagar for a time period of one year. Institutional ethics committee clearance was obtained from the college prior the commencement of study.

A total of 100 participants were taken within the age group from 18 -25 years which were divided into two groups i.e. Group I- 50 female, Group II- 50 male. Participants were selected on the basis of inclusion and exclusion criteria.

Inclusion Criteria

1. Caries free dentition
2. Normal overjet & overbite
3. Angle's class I molar & canine relationship

Exclusion Criteria

1. Partially erupted teeth
2. Excessive Physiologic & pathologic wear
3. Occlusal abnormality like rotation or disharmony
4. Developmental disturbances like amelogenesis imperfecta
5. Habits like bruxism, clenching, thumbsucking & tongue thrust
6. Patient allergic to alginate or having Gag reflexes.

The subjects who fulfilled the requirements were asked to sit up straight in a dental chair, & a perforated imprint tray was filled with alginate paste that had been created using alginate, Type 4 dental stone, 0.051% hydrochloric acid, a spatula, & a mixing bowl. After around 80 to 100 seconds, the tray was taken out of the subject's mouth to take teeth imprints (Figs. 1 & 2), cast using a dental stone & water, & allowed to set (Fig. 3). Later, the solid alignate powder combination (now dental cast) on the imprint tray was separated from the now-solidified dental stone by de-casting. After drying, the resulting casts were tested to ascertain the canine, premolar, & molar indices. Using a digital vernier calliper, the following measurements were made in the dry casts in order to achieve the indices described above. The study model will record the following measurements:

- Canine mesial-distal breadth (upper & lower).
- The distance between dogs (upper & lower).
- The width of the upper & lower premolar arches.
- The width of the upper & lower molar arches.
- The combined width of the upper & lower incisors.

Fig 1: Upper arch Impression

Fig 2: Lower arch impression

Fig 3: Dental Cast

"Mesio-distal canine width: Mesio-distal canine width or the maximum width of canine teeth will be taken as mesio-distal width on right side of the jaw." (Fig. 4)

Fig 4: Mesio-distal canine width

"Inter-canine distance: The inter-canine distance will be measured as the straight line distance between the 2 canines at the most pointed tip of both the canines." (Fig.5)

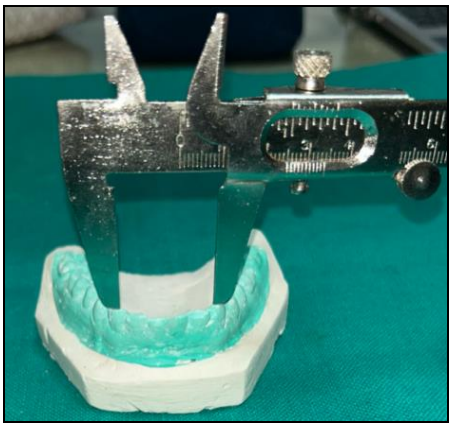

Fig 5: Inter-canine distance

"Premolar arch width: The premolar arch width will betaken as the straight line distance between the left first premolar & right first premolar at the distal end of the occlusal groove." (Fig.6)

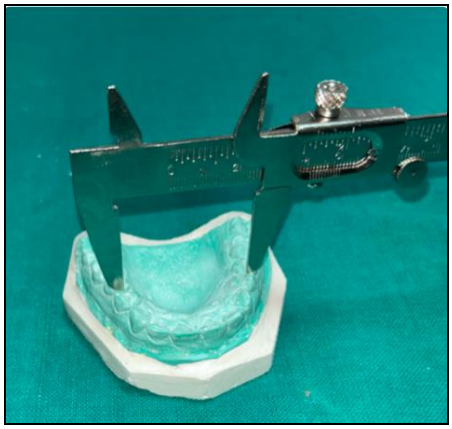

Fig 6: Premolar arch width

"Molar arch width: The molar arch width will be taken as the straight line distance between the left first molar to the right first molar at its mesial pit on the occlusal surface". (Fig.7)

Fig 7: Molar arch width

"Combined width of the incisors: The combined width of the incisors (central & lateral) will be taken at the distal contact points with the canines on either side". (Fig.8)

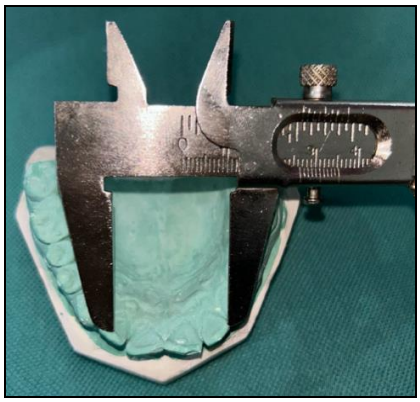

Fig 8: Combined width of the incisors

"Formulae
Mandibular

$$\text{Canine Index} = \frac{\text{Mesio distal crown width of mandibular canine}}{\text{Mandibular canine arch width or inter-canine distance}}$$

Premolar index = (Sum of incisor*100)/Premolar arch width
Molar index = (Sum of incisor *100)/Molar arch width

$$\text{Standard MCI} = \frac{(\text{Mean male MCI–SD}) + (\text{Mean female MCI+SD})}{2}$$

$$\text{Standard premolar index} = \frac{(\text{Mean male PI-SD}) + (\text{Mean female PI+SD})}{2}$$

$$\text{Standard molar index} = \frac{(\text{Mean male MI-SD}) + (\text{Mean female MI+SD})}{2}$$

The data obtained were subjected to statistical analysis using SPSS version 25.0 to determine the accuracy level of indices in predicting sex of an individual keeping level of significance at $p<0.05$.

Results

The average mesio distal width of the right mandibular canine was 5.87±0.42 for males & 5.31± 0.32 for females, according to observations. The average mesiodistal width of the mandibular canine on the left side was 5.42±0.30 for females & 6.02±0.50 for males. Males & females had mean mandibular canine distances of 25.61±0.69 & 25.00±0.31, respectively as shown in table 1.

Table 1: Parameters for Canine Index

Parameters	Gender	Mean±SD	T	P
MIC distance mandibular intercanine distance	Male	25.61±0.69	2.99*	0.03733
	Female	25.00±0.31		
Right MC MD width	Male	5.87±0.42	6.65**	0.00000
	Female	5.31±0.32		
Left MCMD Width	Male	6.02±0.50	5.76**	0.00000
	Female	5.42±0.30		
Right observed MCI	Male	5.99±0.52	6.44**	0.00000
	Female	5.44±0.44		
Left observed MCI Mandibular canine index	Male	6.08±0.50	5.77**	0.00000
	Female	5.99±0.44		

*Significant @ 5% level ($p<0.005$), **Significant @ 1% level ($p<0.001$)

The male & female observed right MCIs were 22.88±2.11 & 22.00±0.44, respectively. For males & females, the observed left MCI was 22.98±2.32 & 20.00±0.12, respectively as shown in table 2.

Table 2: Standard & Observed Canine Index

Canine	Mean± SD		Standard MCI
	Male	Female	
Right Observed MCI	22.88±2.11	20.00±0.44	24.22
Left Observed MCI	22.98±2.32	20.00±0.12	24.24

Male & female maxillary incisor mesiodistal widths were determined to be 29.91±1.88 & 27.00±0.31, respectively, based on Pont's index. For males & females, the mean premolar widths were 37.87±0.42 & 36.31±0.42, respectively. Male & female molar widths were 49.02±0.50 & 47.42±0.30, respectively. Male & female premolar indices were found to be 77.99±0.52 & 76.44±0.44, respectively. Male & female molar indices were found to be 62.08±0.50 & 60.99±0.44, respectively as shown in table 3.

Table 3: Parameters for Pont's Index

Parameters	Gender	Mean±SD	T"	p
MD width of maxillary incisors	Male	28.91±1.88	4.04**	0.00010
	Female	27.00±0.31		
Premolar	Male	37.87±0.42	3.77**	0.00011
width	Female	36.31±0.32		
Molar width	Male	49.02±0.50	7.87**	0.0000
	Female	47.42±0.30		
Premolar index	Male	77.99±0.52	0.99	0.36429
	Female	76.44±0.44		
Molar index	Male	62.08±0.50	1.65	0.7629
	Female	60.99±0.44		

**Significant @1% level (p<0.01). SD: Standard deviation MD: Mesiodistal

The percentage of cases with accurate gender prediction using standard MCI among 50 males (right side: 71.66, left side: 65.86) & females (right side: 75.99, left side: 64.34) as shown in table 4.

Table 4: Comparison of known & estimated gender using standard value for mandibular canine index

Gender	Number of cases studies	Number and proportion of cases where conventional MCI correctly predicts gender	
		Right	Left
Male	50	71.66 %	65.86%
Female	50	75.99%	64.34%

MCI: Mandibile canine index

Using the standard premolar & molar index, the percentage of instances with proper gender prediction among 50 males (right side: 57.66), 50 females (right side: 68.99), & 50 females (left side: 58.34) was as follows as shown in table 5.

Table 5: Comparison of known & estimated gender using standard premolar & molar index value for Pont's index

Gender	Number of cases studies	Number and proportion of cases where standard premolar and molar gender predictions were accurate	
		Right	Left
Male	50	57.66 %	52.86%
Female	50	68.99%	58.34%

Discussion

The frequency of disasters claiming millions of lives worldwide has risen alarmingly in recent years. These events, whether natural or man-made, occur abruptly and often with devastating magnitude, leaving behind large-scale destruction and mass casualties. Natural disasters such as earthquakes, floods, cyclones, and tsunamis, in contrast to man-made disasters including wars, riots, and accidents, present unique challenges in disaster victim identification (DVI). In such situations, accurate identification of deceased individuals becomes essential, both for medico-legal purposes and for providing closure to grieving families. The process of identification depends on a variety of biological parameters, such as age, sex, and race, and requires reliable techniques even when only fragmentary remains are recovered [8, 9].

Forensic specialists frequently encounter incomplete or fragmented skeletal material in mass disasters, including skulls, jaws, or isolated bones. Among the various elements of biological profiling, sex determination is of paramount importance as it narrows down the search for missing individuals to approximately 50% of the population. This not only accelerates the process of identification but also reduces the overall cost and effort involved in large-scale forensic investigations [10]. The skull and pelvis are considered the most reliable skeletal components for sex determination, achieving near 100% accuracy when intact [11]. However, in disaster scenarios, complete skeletons are rarely available, necessitating reliance on more durable structures such as teeth.

Teeth are among the most resilient and chemically stable tissues in the human body, capable of withstanding severe post-mortem conditions such as fire, trauma, and decomposition. They are frequently recovered in mass casualty incidents and are thus considered excellent resources for forensic analysis. Teeth exhibit sexual dimorphism in various dimensions, including mesio-distal widths, inter-canine distances, and arch widths, making them useful adjuncts in sex estimation when skeletal remains are absent [11].

A variety of methods have been utilized in dental-based identification, including DNA profiling, radiographs, bite mark analysis, tooth prints, rugoscopy, cheiloscopy, and photographic study. While DNA profiling is the most accurate technique, it is time-consuming, expensive, and technically demanding, limiting its utility in mass disasters. Odontometric methods, in contrast, are simpler, faster, and cost-effective, providing a practical alternative in resource-constrained or urgent circumstances [12].

The measurement of linear tooth dimensions has long been employed in forensic dentistry to evaluate sexual dimorphism. Parameters such as mesio-distal canine widths, inter-canine distances, inter-premolar and inter-molar arch widths, and combined incisor widths are widely studied. Numerous authors have reported that mandibular canines exhibit the highest degree of sexual dimorphism, making them the most reliable teeth for sex determination [13, 14].

The mandibular canine index (MCI), derived from canine width and inter-canine distance, has been proposed as a useful parameter in forensic sexing. Several studies, including those by Kaushal *et al*, Reddy *et al*, and Abdullah, have confirmed the significant role of MCI in distinguishing between males and females [13-15]. In the present investigation, males demonstrated significantly greater mesio-distal canine widths and inter-canine distances compared to females, consistent with previous findings. The predictive value of the MCI in this study ranged from 65% to 75%, which is in agreement with Mughal *et al*, who reported an accuracy of 75.97% in a Punjabi population [16].

Similarly, Pont's index—based on maxillary premolar and molar arch widths—was evaluated for its applicability. Although originally developed for European populations, subsequent studies have tested its relevance across different ethnic groups. In the present study, premolar and molar widths were significantly greater in males than females, demonstrating sexual dimorphism. These findings align with Agnihotri *et al*, who reported similar results in a North Indian population [17]. However, predictability levels based on Pont's index were generally lower than those obtained through the MCI, suggesting that while useful, Pont's index may be more population-specific.

The observed differences in tooth size between males and females are attributed to both genetic and environmental factors. Moss proposed that sexual dimorphism arises because males experience longer periods of amelogenesis, resulting in thicker enamel. Additionally, the influence of the Y chromosome contributes to slower male maturation and larger tooth dimensions. These biological mechanisms account for consistent observations of larger mesio-distal canine widths and arch dimensions in males across multiple populations [18, 19].

However, the degree of dimorphism varies significantly across populations. For instance, Rastogi *et al*. [20] reported higher predictive accuracy for canine width than MCI in their sample, whereas Acharya & Mainali observed relatively poor accuracy of MCI in a Nepalese population [12]. Such discrepancies highlight the strong influence of ethnicity, culture, diet, and environment on tooth morphology.

The present findings are in accordance with those of Kaushal *et al*., [14] who demonstrated a 75% accuracy rate in sex determination using MCI in Punjabi populations. Similarly, Reddy *et al* confirmed that males consistently exhibit larger canine widths and inter-canine distances [13]. In contrast, Acharya & Mainali found limited applicability of MCI in a Nepalese population, suggesting that odontometric standards cannot be universally applied. This underlines the importance of generating population-specific data for accurate forensic applications [12].

Furthermore, the current study supports the findings of Dhara *et al*, who observed significant gender differences in mandibular canine dimensions [21]. The results also corroborate observations from studies conducted in Saudi arabia, Chinese, Nigerian, and Brazilian population, indicating that while sexual dimorphism is a universal phenomenon, its degree and forensic utility vary among populations [7].

The findings of this study have significant forensic implications. The demonstration of sexual dimorphism in mandibular canine dimensions and arch widths supports the utility of odontometric analysis as a reliable method for sex determination in the Sri Ganganagar population. By establishing population-specific standards for MCI and Pont's index, forensic experts can improve the accuracy of disaster victim identification. Furthermore, combining odontometric analysis with other forensic techniques can enhance the robustness of sex determination.

One of the limitations of the present study is its relatively small sample size. A larger and more diverse sample would provide more representative data for establishing population-specific odontometric standards. Moreover, missing canines due to extraction, attrition, or pathology may reduce the applicability of MCI in forensic settings. Similarly, Pont's index, being originally derived from French populations, may not be universally applicable without population-specific calibration.

Another limitation is that odontometric methods alone cannot provide definitive identification. They are best employed as adjuncts to other techniques such as DNA analysis, anthropometry, and radiographic methods. Nevertheless, in mass disasters where rapid and economical techniques are necessary, odontometric analysis offers valuable preliminary data.

Conclusion

The standard MCI & Pont's indices are a quick & simple way to determine sex in personal identification, but as the accuracy rate has never surpassed 84-87% in any prior study, one must be cautious when interpreting the results & validate them using other methods. More research on a larger population is required to comment more specifically on the method's usefulness. Additionally, since tooth form shape size also depends on cultural, genetic, & physical factors, it must be conducted at different ethnic populations. For comparability & reliable statistics, it is therefore advised that more research be done on other ethnic groups.

Conflict of Interest

Not available

Financial Support

Not available

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