

## Crown Size and Arch Width Dimension as an Indicator in Gender Determination in Rajasthani Population in Sriganganagar

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### ABSTRACT

**Aim:** To evaluate the crown size and arch width dimension by comparing and validating MCI and Pont's index for the level of accuracy in gender determination for the population in Sri Ganganagar, Rajasthan

**Materials and Methods:** A total of 100 participants were taken within the age group from 18 -25 years. Their MCI (mandibular canine index) and Pont's index will be recorded. These records will be assessed for gender determination.

**Results:** In this study, evaluation of the crown size and arch width dimension for the Sri Ganganagar population using MCI and Pont's index was done and were compared for accuracy levels in gender determination. The results showed not only the existence of a correlation between the mesiodistal width of anterior maxillary teeth and premolar and molar arch width but also the existence of sexual dimorphism in premolar and molar indices. When compared, the mandibular canine width, inter-premolar and inter-molar arch width were found to be rather helpful in the identification of gender. When indices were compared for their accuracy in gender determination, MCI was found to be more accurate in gender determination than Pont's index. Hence, the results of this study indicate that dental indices such as canine index and Pont's index show significant sexual dimorphism for the Sriganganagar population and could be used as an aid in gender determination.

**Conclusion:** The standard MCI and Pont's indices fall under an easy and fast method for determining sex in personal identification, but one must be careful in interpreting the results and must be confirmed by other methods. Since the sample size in the studies has been low further studies on a larger number of populations is needed at various ethnic populations.

**Keywords:** Forensic dentistry, sex determination, mandibular canine index(MCI), pont's index.

### INTRODUCTION

Human identification is the foundation of civilization, and the unique features of the teeth and jaws have been used since Roman times for such identification of unknown individuals. Teeth were selectively preserved and fossilized, thereby providing by far the best record used even today to study evolutionary changes.<sup>1,2,3</sup> Forensic

odontology is an investigative part of dentistry that applies dental principles to legal issues that analyze dental evidence for human identification.<sup>4,5</sup> And hence provides information to support the Court of Justice decisions, especially with regard to identification and clarification of facts with legal interest.<sup>6,7</sup>

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Forensic dentistry specifically has played a key role in the quick and cheaper mode for identification of victims of high-speed accidents, social violence and natural disasters. Its various techniques used include bite marks registration, radiographic analysis, photographs, DNA analysis, cheiloscopy and rugoscopy. The accuracy of gender determination using diverse parameters of the body such as craniofacial morphology and measurements on the pelvis ranges from 96% to 100%.<sup>2,4,8</sup>

The four most important features of biological identity are sex, age, stature, and ancestry background. The forensic anthropologists wish to authenticate these traits for an individual from their skeletal remains.<sup>8</sup> The identification of human in case of major disasters where bodies are often damaged beyond recognition is difficult work. Furthermore, they show significant sexual dimorphism.<sup>1</sup> Sexual dimorphism refers to those differences in size, stature, and appearance between male and female that can be applied to help in dental identification of a person. In the last few years, DNA techniques have been developed, providing for accurate sex determination. However, it is expensive and time assuming apart from being a tedious job, hence usually some skeleton measurements are enough for sex identification.<sup>6</sup>

Determining gender is one of the most important parameters in forensic odontology as an assessment of sex has significant contribution in the construction of a physical profile of the decedent along with other parameters like race, stature and age.<sup>2,6</sup> It is very important, especially when any information relating to the deceased is unavailable.<sup>8</sup> Teeth being the strongest, hardest and chemically the most stable tissue, which exhibits the least turnover of natural structure in the body may be used for age and sex determination.<sup>1,3</sup>

Teeth are known to be the most enduring mineralized tissues in the human body and are resistant to damage in terms of mechanical, thermal, chemical, physical form, even in the face of fire, and bacterial decomposition makes them valuable for forensic investigation and research purpose.<sup>2</sup> With the aid of econometric analysis in which metric parameters of the tooth such as mesiodistal, buccolingual width, arch width are measured using a vernier calliper. It has been suggested that odontometric plays a very important role in gender

determination in young individuals where secondary sexual characteristics have not developed.<sup>1,2,3</sup>

Of all teeth in the dentition canine, specifically the mandibular canine shows maximum sexual dimorphism and is considered as the “key teeth” for person’s identification<sup>1,3</sup>. Canine Index is a simple odontometric method which uses mandibular canines to find gender dimorphism. The canine index is defined as the ratio between the mesiodistal diameter of mandibular canine and intercanine arch width<sup>4</sup>. Studies performed on the lower canine using the ratio between mandibular crown width and intercanine width, i.e. mandibular canine index (MCI), have shown an ability to determine gender with an accuracy of as much as 83.3% in males and 81% in females by comparing observed MCI with standard MCI value, respectively.<sup>1,3</sup> Males have larger crowns with more dentine than females. Garn and Nair in 1967 found and stated that the mandibular canines exhibit the greatest gender dimorphism among all teeth.<sup>4</sup>

Mandibular canines are also considered as the “key teeth” for personal identification since higher survival rate due to anatomical reasons i.e good bone support, long roots, position in the arch. The measure of the coronal tissue proportions of permanent mandibular canines suggests that males have heavier teeth and than their female counterparts. The mesiodistal measure of mandibular canine and the mandibular intercanine distance are a simple, inexpensive method that can be used in forensic odontology establishing sex identity particularly in adults aged 18–25 years.<sup>7</sup>

Gender dimorphism in tooth size has been studied by anthropologists and odontologists focusing on Buccolingual and Mesiodistal dimensions of teeth, and it is known that gender dimorphic dimensions are only useful if relative to a population. Gender determination using linear dimensions of maxillary and mandibular teeth among the Sir Ganganagar population is lacking in the literature and its this gap in the literature that this study intends to fill. The present study is an attempt to present econometrics as an easy-to-use, inexpensive, simple, reliable technique to determine gender in archaeological circumstances without the need for complicated DNA profile and statistical software.<sup>2</sup>

## AIM AND OBJECTIVES

To evaluate the crown size and arch width dimension using MCI and Pont's index of the population in Sri Ganganagar, Rajasthan.

### Objectives

To compare the MCI and Pont's index, for the level of accuracy in gender determination for the population in Sriganganagar, Rajasthan.

To validate the use of MCI and Pont's index as a forensic tool.

### Materials and methods:

The present in vivo study was undertaken in the Department of Oral and Maxillofacial Pathology, Maharaja Ganga Singh Dental College and Research Centre, Shri Ganganagar. Institutional ethics committee clearance was obtained from Maharaja Ganga Singh Dental College and Research Centre, Shri Ganganagar

**Grouping of samples:** A total of 100 patients were taken within the age group from 18 -25 years which were divided into two groups, i.e. group I female participants and group II male participants

**Inclusion Criteria:** Caries free dentition, Normal overjet and overbite, Angle's class I molar and canine relationship

**Exclusion Criteria:** Partially erupted teeth, Excessive Physiologic and pathologic wear, Occlusal abnormality like rotation or disharmony, Developmental disturbances like amelogenesis imperfect, Habits like bruxism, clenching, thumb sucking and tongue thrust

**Clinical examination and grading:** After complete clinical examination and assessment of participants, alginate impression of the upper and lower arch was made for selected participants, and study models will be prepared with dental stone. Their MCI(mandibular canine index) and Pont's index were recorded. These records were assessed for gender determination.

Informed consent of all the subjects was obtained prior to the study. The following measurements were recorded on study models:

- Mesiodistal width of the mandibular canines
- Mandibular intercanine distance
- Maxillary premolar arch width
- Maxillary molar arch width
- Combined width of the maxillary incisors

The data obtained were subjected to statistical analysis to determine the accuracy level of indices in predicting the sex of an individual.

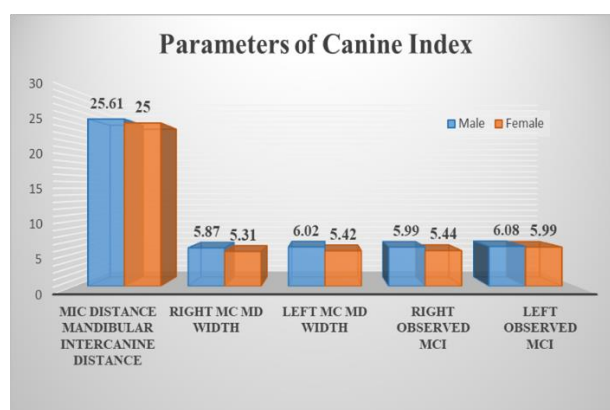
### A) STATISTICAL ANALYSIS

Table 1: Parameters for canine index

|                                              | 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 MC MD 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                            | 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)

Graph 1: Parameters of canine index.



**Inference:** table 1 graph 1: It has been observed that mean mesiodistal width of the right mandibular canine was found to be  $5.87 \pm 0.42$  for male and  $5.31 \pm 0.32$  for female. For the left side, mean mesiodistal width of the mandibular canine was found to be  $6.02 \pm 0.50$  for male and  $5.42 \pm 0.30$  for female. The mean mandibular canine distance was

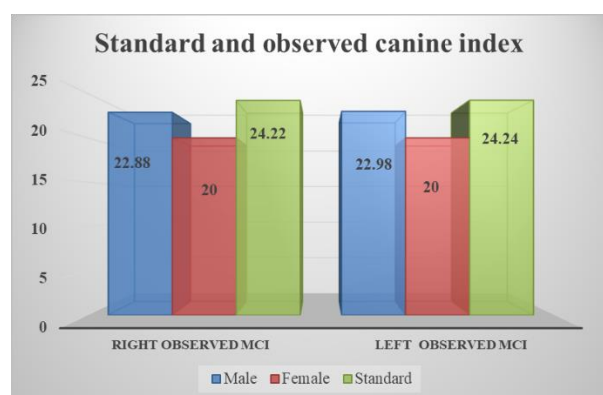
found to be  $25.61 \pm 0.69$  for male and  $25.00 \pm 0.31$  for female.

Table 2: Standard and observed canine index.

| CANINE             | Mean± SD   |            | Standard MCI |
|--------------------|------------|------------|--------------|
|                    | MALE       | FEMALE     | 24.22        |
| Right observed MCI | 22.88±2.11 | 20.00±0.44 | 24.24        |
| Left observed MCI  | 22.98±2.32 | 20.00±0.12 |              |

MCI : mandible canine index , SD ; standard deviation

Graph 2: Standard and observed canine index.



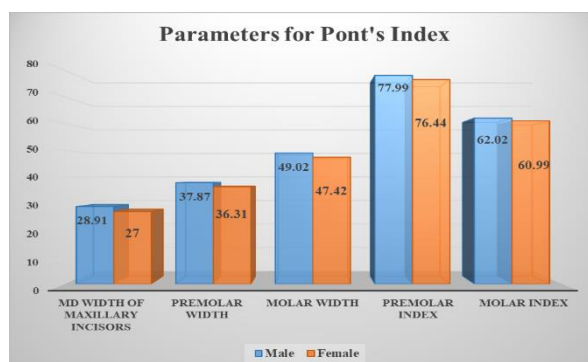
Inference table 2 graph 2: The observed right MCI was found to be  $22.88 \pm 2.11$  and  $22.00 \pm 0.44$  for male and female, respectively.

The observed left MCI was found to be  $22.98 \pm 2.32$  and  $20.00 \pm 0.12$  for male and female, respectively

Table 3. Parameters for Pont's index.

|                                | 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 width                 | MALE   | 37.87±0.42 | 3.77** | 0.00011 |
|                                | 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 |        |         |

Graph 3: Parameters for Pont's Index.



Inference table 3 graph 3: For Pont's index,

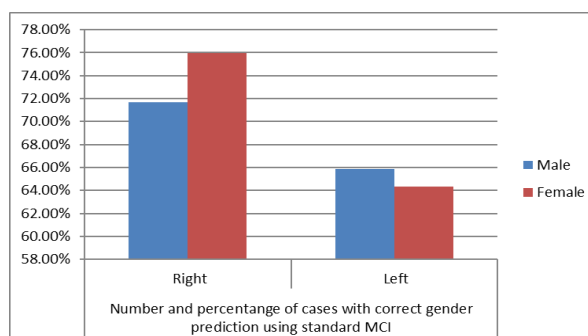
mesiodistal width of maxillary incisors was found to be  $29.91 \pm 1.88$  and  $27.00 \pm 0.31$  for male and female, respectively. Mean premolar widths were  $37.87 \pm 0.42$  and  $36.31 \pm 0.42$  for male and female, respectively. Molar widths were  $49.02 \pm 0.50$  and  $47.42 \pm 0.30$  for male and female, respectively. Observed premolar indices were  $77.99 \pm 0.52$  and  $76.44 \pm 0.44$  for male and female, respectively. Observed molar indices were  $62.08 \pm 0.50$  and  $60.99 \pm 0.44$  for male and female, respectively

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

| GENDER | Number of cases studies | Number and percentage of cases with correct gender prediction using standard MCI |        |
|--------|-------------------------|----------------------------------------------------------------------------------|--------|
|        |                         | Right                                                                            | Left   |
| Male   | 50                      | 71.66 %                                                                          | 65.86% |
| Female | 50                      | 75.99%                                                                           | 64.34% |

MCI: Mandible canine index

Graph 4: Number and percentage of cased with correct gender prediction using standard MCI.

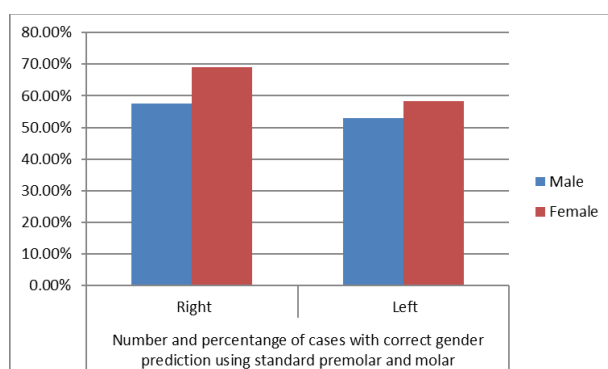


Inference table 4 graph 4: Percentage of cases among 50 male right sides 71.66, left side 65.86 and female right side 75.99, left side 64.34 respectively with correct gender prediction using standard MCI

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

| GENDER | Number of cases studies | Number and percentage of cases with correct gender prediction using standard premolar and molar |        |
|--------|-------------------------|-------------------------------------------------------------------------------------------------|--------|
|        |                         | Right                                                                                           | Left   |
| Male   | 50                      | 57.66 %                                                                                         | 52.86% |
| Female | 50                      | 68.99%                                                                                          | 58.34% |

Graph 5: Number and percentage of cases with correct gender prediction using standard premolar and molar.



Inference table 5 graph 5: Percentage of cases with correct gender prediction using standard premolar and molar index among 50 male right sides 57.66, left side 52.86 and 50 female right side 68.99 and left side 58.34 respectively

## DISCUSSION

In recent times, there have been exponentially increased rates of disasters costing millions of lives around the world. In these situations, there's a need to precisely recognize the remains of dead individuals, which depends on various factors like individual's race, sex and age. In mass disasters, forensic experts in many cases recover partial remains like fragmented body parts, skull, jaws and other bones of the body. Identification of sex is one of the most important steps for identification of a

person.<sup>13</sup>In forensic medicine, identification of gender from human skeletal remains is most reliable if the entire skeleton is available for analysis. Sex assessment of skeletal remains is an important step in building the biological profile of unidentified skeletons recovered in forensic contexts.<sup>10</sup>Among skeletal parameters, the pelvic and skull bones are known to produce approximately 100% success in sex identification. The sexual difference in the human skeleton has been well studied in many populations (Bilge, et al., 2003) with an accuracy rate of determining the correct sex being as much as 100% (Iskan and Kedici, 2003).<sup>10</sup>

However, in the absence of the entire skeleton, skull and teeth often are the only identification material available, and sex determination from these skeletal remains is usually complex.<sup>1</sup>The teeth, while not as accurate as skeleton remains, are considered a useful adjunct in sex assessment (Kieser, 1990).<sup>14</sup>The different methods employed as a reference and identification marker by odontologists and forensic analysts include Bite mark analysis, tooth prints, Rugoscopy, Cheiloscopy, Dental DNA analysis, Radiographs and Photographic study etc. Using DNA Profile, a person's identity can be most accurately determined, but it is expensive, requires the complex procedure, and hence it is more time-consuming. It has been well established that teeth are one of the strongest and chemically most stable tissues in the human body which can resist a variety of antemortem and postmortem insults apart from being one of the most frequently recovered remains. Further, they show significant sexual dimorphism and are readily accessible for examination. Thus, they provide excellent materials for forensic studies involving the identification of genders.<sup>8</sup>

It has already been opined that in the present-day humans, sexual dimorphism in mandibular canines is not merely a coincidence but can be expected to be based on functional activity.<sup>9</sup>Moreover, mandibular canines exhibit the greatest sexual dimorphism amongst all teeth and differ from other teeth with respect to the high level of survival in dentition.<sup>9</sup>

in this study, inter-premolar and inter-molar arch width were measured and were used to determine the gender and the observed results were then



compared with inter-canine arch width, thereby assessing a better method to establish gender accurately.<sup>13</sup> This study suggests that the mean inter-canine width, inter-premolar width and the mean inter-molar width were significantly higher in males than females.<sup>13</sup>

Several studies have reported the existence of significant differences between men and women's tooth size, with a tendency for men to present larger teeth on mesiodistal direction.<sup>15</sup>

Dunn and Dobzhansky have indicated that although all human beings belong to a single species; however, humans inhabiting different parts of the world are exposed to different environments and are not alike.<sup>2</sup> Various authors like Richardson & Malhotra, Santoro et al., Singh & Goyal have presented literature for tooth dimensions of different populations some variations in tooth sizes between gender and among different racial and ethnic groups were observed.<sup>2</sup>

In this study, evaluation of the crown size and arch width dimension for the Sri Ganganagar population using MCI and Pont's index was done, and the MCI and Pont's index were compared for accuracy levels in gender determination and to validate its use as a forensic tool.

In this study, 100 participants were selected as per the mentioned inclusion and exclusion criteria. the average ages included in this study were individuals between the age of 18 and 25 years so as to minimize the influence of attrition, damages and other factors on the actual size of the tooth.<sup>16</sup>

Standardized methods were used for the measurement of mesiodistal width of the mandibular canine and intercanine distance to calculate MCI.<sup>12</sup> Similarly, for maxillary arch, standardized methods were used for the measurement of mesiodistal width of incisors and premolar and molar width to calculate Pont's index.<sup>12</sup> The mean value and standard deviation were used to derive population-specific standard MCI and standard Pont's index (premolar and molar index).<sup>12</sup> This study focused on the mandibular measurements like canine width, intercanine distance, premolar arch width, molar arch width, the combined width of the incisors and the respective indices of canines, premolars and

molars.<sup>12</sup> Data was analyzed using student t-test, and linear and multiple regression equations were derived using these parameters.<sup>12</sup>

The intercanine distance both in males and females was found to be significant i.e. in males  $25.61 \pm 0.69$  mm and the value in females was  $25.00 \pm 0.31$  mm showing the values higher in males than in females (table 1 and graph 1).

It has been observed that mean mesiodistal width of the right mandibular canine was found to be  $5.87 \pm 0.42$  for male and  $5.31 \pm 0.32$  for female. For the left side, mean mesiodistal width of the mandibular canine was found to be  $6.02 \pm 0.50$  for male and  $5.42 \pm 0.30$  for female. The mean mandibular canine distance was found to be  $25.61 \pm 0.69$  for male and  $25.00 \pm 0.31$  for female [ table 1 and graph 1].

The observed right MCI was found to be  $22.88 \pm 2.11$  and  $20.00 \pm 0.44$  for male and female, respectively [Table 2 and graph 2] The observed left MCI was found to be  $22.98 \pm 2.32$  and  $20.00 \pm 0.12$  for male and female, respectively [Table 2]. So the standard mandibular canine index (MCI) is 24.22 on the right side and 24.24 on the left side [table 2 and graph 2]. There is a significant gender difference with p value  $< 0.05$  on values of canine arch width, premolar arch width and molar arch width. This is in accordance with the study conducted by Dhara et al. for canine arch width<sup>14</sup>.

The present study also shows that the predictive value of determining the gender of a person is useful by using mandibular canine width and index. The usefulness of the canines as an aid in sex determination by odontometric analyses is supported by their high level of survival in the dentition.<sup>9,12</sup> The notable difference between canine in determining sex was noted to be due to the nonuniform influence of the Y-chromosome in all teeth. On the other hand, the X-linked genetic influence on tooth width was rather uniform for all teeth.<sup>1,9</sup>

According to Dhara et al<sup>14</sup> and Rajbir Kaur et al<sup>11</sup>, the mean mesiodistal canine width is higher in males when compared with females. In this study, the p-value of the mandibular canine index reveals that there is a significant gender difference on a canine index which in accordance to studies conducted by Kalia.<sup>1,11,14</sup>

Canines are of definite significance as the tooth morphology is known to be influenced by cultural, environmental and racial factors<sup>12</sup>. Variation in food resources exploited by different populations has been explained as one such environmental cause<sup>12</sup>. The reason behind this sexual dimorphism of canine amongst various populations has been explained by various theories.

A) According to Moss, it is because of the greater thickness of enamel in males due to the long period of amelogenesis compared to females.

B) Because of Y chromosomes producing slower male maturation.<sup>8</sup>

The values of mandibular premolar arch width, molar arch width, molar index and premolar index are greater in males when compared with females. This clearly reveals that not only mandibular canine shows sexual dimorphism but also mandibular premolars and molars may be included as one of the tooth exhibiting sexual dimorphism.<sup>7,8,9</sup>

The percentage of cases with correct gender prediction when the mandibular canine index was used, in males on the right side is 71.66% and left side is 65.86% while in females right side 75.99% and left side 64.34% of total 100 cases studied. [table 4 and graph 4] This data shows the prediction level is higher on the right side as compared to on left side and is higher in females.

For Pont's index, mesiodistal width of maxillary incisors was found to be  $28.91 \pm 1.88$  and  $27.00 \pm 0.31$  for male and female, respectively [Table 3]. Mean premolar widths were  $37.87 \pm 0.42$  and  $36.31 \pm 0.32$  for male and female, respectively [Table 4 and graph 3]. Molar widths were  $49.02 \pm 0.50$  and  $47.42 \pm 0.30$  for male and female, respectively [table 3 and graph 3]. Observed premolar indices were  $77.99 \pm 0.52$  and  $76.44 \pm 0.44$  for male and female, respectively. Observed molar indices were  $62.08 \pm 0.52$  and  $60.90 \pm 0.44$  for male and female, respectively [table 3 and graph 3].

There is a greater value of premolar and molar arch width in males when compared with females. The comparison of known and estimated gender using standard value for standard premolar and molar index as a guide, when premolar and molar index was used in males right side 57.66% and left side 52.86% while in females, right side 68.99% and left

side 58.34% with significantly higher predictability in females and overall on right side [ table 5 and graph 5].

When a standard mandibular canine index is compared with premolar and molar index as a guide for gender determination, the mandibular canine index shows higher predictability on both sides in males and females with comparatively higher predictability in females and on the right side.

In this study, the results showed not only the existence of a correlation between the mesiodistal width of anterior maxillary teeth and premolar and molar arch width but also the existence of sexual dimorphism in premolar and molar indices which is found to be in accordance with the present study.<sup>1</sup>

When compared, the mandibular canine width, inter-premolar and inter-molar arch width were found to have high 't' values and were found to be rather helpful in the identification of gender. This finding might be due to considerable variation in the arch width between both genders or can also be attributed to race.<sup>33</sup>

When indices were compared for their accuracy in gender determination, MCI was found to be more accurate in gender determination than Pont's index.<sup>1</sup>

Hence, results of this study indicate that dental indices such as canine index and Pont's index show significant sexual dimorphism for the Sri Ganganagar population and could be used as an aid in gender determination provided population-specific standard values for these indices are available.<sup>1</sup>

Larger sample size increases the accuracy of the result. The small sample size is one of the limitations of this study. The standard value of the dental index for a population would be more precise if calculated from a larger sample as it would be a better representative of the variation in odontometric measurements in a population.<sup>1</sup>

Similar studies could be done on other populations in order to examine the applicability of this sexual dimorphism method in determining gender when partial human remains are recovered and for future reference. It must be noted, however, that identification of sex through mandibular canine has

its limitations; the gender of the subject to whom the fragment of the mandible belongs can be determined adequately when the fragment is found in the geographical area where the subject was born.<sup>7</sup>

Such method of gender determination has certain limitations as the sex of the subjects to whom the fragment of the mandible belongs can be determined at best preferably if the fragment is found in the geographical area where the subject was born so that the results can be compared. This implies that it is necessary to make up a random sample of the population from this geographical area to calculate the corresponding standard mandibular canine index<sup>17</sup>.

## CONCLUSION

The standard MCI and Ponts indices falls under an easy and fast method for determining sex in personal identification, but one must be careful in interpreting the results and must be confirmed by other methods since accuracy rate has never exceeded 84-87% in any previous study done. However, since the sample size in the studies has been low further studies on a larger number of population is needed for more specifically comment on the usefulness of the method also it needs to be done at various ethnic populations since tooth form shape size also depends on cultural, genetics and physical factors. Hence it can be recommended that further studies be carried out on various ethnic populations for comparison and robust data.

## CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

## REFERENCES

1. Gupta J, Daniel Mj. Crown Size And Arch Width Dimension As An Indicator In Gender Determination For A Puducherry Population. J Forensic Dent Sci 2016;8:120-5.
2. Metgud R, Surbhi, Naik S, Patel S. Odontometrics: A Useful Method For Gender Determination In Udaipur Population. J Forensic Investigation. 2015;3(2): 5.
3. Ritu Jindal, Rohini Dua, Eera Bunker Sex Determination Using Arch Width In North Indian (Punjab) Population. International Dental Journal Of Student's Research 2013;2(1)
4. Gardezi S, Hassan N, Memon S. Canine Index For Gender Dimorphism In A Subset Of Karachi Population J Pak Dent Assoc 2018;27(3):120-23
5. Pagare N, Chourasiya S And Dedhia H. Study Of Odontometric Parameters In Gender Identification. Austin J Forensic Sci Criminol. 2017; 4(2): 1060.
6. Divakar Seetharaman, Fremingston Marak, Jonathan Mariappan Daniel, Srinivasan Subramanian Vasudevan, Jimsha Vannathan Kumaran. Accuracy Of Canine, Premolar And Molar Indices In Sex Determination Indian Journal Of Forensic And Community Medicine, 2016;3(4):245-250.
7. Fouad Ayoub, Loubna Shamseddine, Mohamad Rifai, Antoine Cassia, Randa Diab, Ibrahim Zaarour, Maria Saadeh And Georges Rouhana Mandibular Canine Dimorphism In Establishing Sex Identity In The Lebanese Population. International Journal Of Dentistry 2014,1-4
8. Gupta B, Gupta M. Sex Identification In Forensic Odontology- A Review Of Various Methodology. Int J Forensic Odontol 2016;1:9-13.
9. P. C. Srivastava Correlation Of Odontometric Measures In Sex Determination Indian Acad Forensic Med , 32:1
10. Sittiporn Ruengdit, Suda Riengrojpitak, Montip Tiensuwan, Peerapong Santiwong Sex Determination From Teeth Size In Thais The 6th Cifs Academic Day 2011
11. Rajbir Kaur Khangura, Keya Sircar, Sanjeet Singh, Varun Rastogi Sex Determination By Maxillary Anterior Teeth Journal Of Forensic Dental Sciences 2011,3:2
12. Rastogi P, Jain A, Kotian S, Rastogi S (2013) Sexual Diamorphism-An Odontometric Approach. Anthropol 2013;1: 104
13. G Venkat Rao,G Kiran Sex Determination By Means Of Inter-Canine And Inter-Molar Width-



- A Study In Telangana Population Asian Pacific Journal Of Health Sciences, 2016; 3(4): 171-175
14. Dhara Parekh, Ankur Zalawadia, Shailesh Patel Comparison Of Canine Indices For Sexual Dimorphism In Gujarat Region Ijbaa 2017; 1:1 Dental Journal 2017, 37:1
  15. Fernandes Tmf, Sathler R, Natalício Gl, Henriques Jfc, Pinzan A. Comparison Of Mesiodistal Tooth Widths In Caucasian, African And Japanese Individuals With Brazilian Ancestry And Normal Occlusion. Dental Press J Orthod. 2013,18(3):130-5.
  16. Amjad M Alwarawreh Mohammed A Al-Qudah Emad A Shtaiwi Albdour Tamara Trad Al Zoubi Mohammed H Ammouh Lana A Obeidat Average Tooth Size In South Jordanian Population Pakistan Oral & Dental Journal 2016,36:1
  17. P.O. Otuaga And L.E. Chris-Ozoko Sex Determination In Deltans Using Mandibular Canine Biomedical & Pharmacology Journal 2012 5:1;111-115.