



## Association Between Different Palatal Parameters with Maxillary Arch Form and Arch Perimeter as Predictive Measures in Chhattisgarh Population: - An *In vitro* Study

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### ABSTRACT

To investigate the morphology of the hard palate in order to create a general guideline of the different palatal parameters in Chhattisgarh region and determine the possible correlations between them in class I malocclusion with the maxillary arch form and perimeter. 40 study models of orthodontic patients aged 16–24 years old who had reported to the department of orthodontics and dentofacial orthopedics in Maitri College of Dentistry and Research Institute is included in this study. In this study, palatal measurements including depth, length, and width were measured by digital vernier caliper to discover their correlation with each maxillary arch form and perimeter. Additionally, measurements of intermolar width, inter-canine width, and arch perimeter were carried out. Nearly 80% of the study sample had high palate followed by 20% of medium palate and 67.5% have narrow palate followed by 25% and 7.5 % of intermediate and broad palate respectively. In regard to arch form, almost 80% of subjects were with tapered maxillary arch form, 12.5% of them were with square arch form and 7.5 % were with oval arch form. Most of the subjects had narrow and high type of palate with tapered arch form. Positive correlation was seen between arch perimeter and palatal canine depth, palatal length and width and between palatal canine depth, palatal length and Arch form.

**Keywords:** -Palatal parameter, Arch form, Arch perimeter, Intermolar width, Intercanine width

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### INTRODUCTION

Information concerning maxillary arch dimensions in human populations is important to clinicians in orthodontics, prosthodontics, and oral surgery [1] Due to the morphology and position of the palate, it is considered to be a key anatomical structure that determines skeletal patterns [2]. The morphometric features of the palate are of great importance in clinical dental sciences. The length, depth, and width of the palate have had considerable importance in orthodontic treatment planning and in the early diagnosis of craniofacial disorders [3].

Orthodontic treatment usually requires modifications in arch dimensions for the correction of the presenting malocclusions. Arch dimensions are also modified by the various arch wires used during treatment affecting the stability of the results achieved. Consequently, the dimensional changes ultimately affect arch form, reflecting the underlying bone morphology [4]. Stability of arch form is one of the most desirable goals of orthodontics, yet unfortunately it is the least understood.

Dental arch perimeter is regarded as one of the most vital dental arch parameters for orthodontic diagnosis and treatment planning. Dental arch and soft tissue parameters can be considered age-dependent factors in untreated persons with orthodontic appliances. The greatest increase in the upper arch perimeter occurs during the mixed dentition period which may be ascribed to the permanent incisor eruption as well as to the largest mesiodistal width of primary molars compared to premolars, with a decreased perimeter being observed with advanced age [4]. Accordingly, many authors have reported an increase in dental arch perimeter until permanent dentition completion that is followed by a diminution of this dimension with age, especially in the mandibular arch [5].

Maxillary arch palatal dimensions are influenced by several factors including the shape and size of the jaws and the type of malocclusion. Stability of the post-treatment results is one of the goals of orthodontic treatment, as the arch form tends to return back to original form. Depending on the individual's facial form, their arch form can be easily identified. For instance, brachiocephalic persons typically have broad

dental arches, whereas dolichocephalic persons have long or narrow dental arches and mesocephalic individuals usually have paraboloid or average dental arch form [6].

Sexual dimorphism is demonstrated by some palatal dimensions, so they can be used as predictors of sex. The sexual dimorphism of palatal dimensions is displayed in adults, and it is also demonstrated in children. Additionally, sex probably plays an essential role in the determination of palatal dimensions and the changes that occur during developmental growth [1]. The palatal dimensions are observed to be higher in males than in females. On the other hand, in a study by Al-Mulla *et al* [6], who investigated the palatal depth of 50 maxillary study models of patients (18 males and 32 females) aged 15–20 years old, they reported that the difference between males and females was not significant [7].

Westerman *et al.* compared palatal dimensions (width, depth, length) obtained from patients with Down's syndrome in a control population. Their results demonstrated that the palatal dimensions of participants with Down's syndrome were narrower in width, shorter in depth, lower in length [8].

Eid *et al.* used three-dimensional orthodontic caliper for measuring the dental arch width and the palatal vault depth, and they found no significant correlation between arch perimeter and the palatal depth [9].

Al-Mulla *et al.* investigated the palatal depth on 50 maxillary study models of patients (18 males and 32 females) aged 15-20 years old. They found that there was no significant difference between males and females [10].

In addition, knowledge of normal palatal dimension values can be used as a basis when studying oral developmental abnormalities. Palatal dimensions have been reported to be influenced by ethnicity, dietary regimes, and environmental factors. Every ethnic group and population affinity has its own unique facial and cranial form [9]. People may also have slightly different characteristics and facial shapes from individuals of other cultures in different countries. Thus, encouraging researchers worldwide to document dental arch dimensions and forms in several populations and races. To investigate the morphology of the hard palate in order to create a general guideline of the different palatal parameters in Chhattisgarh region and Determining the possible correlations between them in class I malocclusion with the maxillary arch form and perimeter.

## MATERIAL AND METHODS

The sample comprised of 40 study models of orthodontic patients who had reported to the department of orthodontics and dentofacial orthopedics in Maitri College of Dentistry and Research Institute are included in this study.

### SAMPLE SELECTION

#### Inclusion Criteria

- Patients with fully erupted complete set of permanent dentition aged from 16 to 24 years.
- Mild to moderate Class I malocclusion cases with a normal upper midline.
- No history of previous orthodontic and orthognathic treatments.
- No congenital and developmental abnormalities.

#### Exclusion Criteria

- Class II or Class III malocclusion cases.
- History of extracted permanent teeth.
- History of significant respiratory and allergic problems.

Pretreatment study models of the selected individuals were collected and variable parameters were measured using digital vernier caliper with accuracy of 0.001 mm.

The following linear measurements were recorded :-

- Maxillary arch measurements:
  - i. Inter-molar width: the linear distance at the level of the molar mesio-buccal cusp tips (Figure 1A).
  - ii. Inter-canine width: the linear distance at the level of the canine cusp tips (Figure 1B).
  - iii. Arch perimeter: the dental arch perimeter was obtained by summation of five segmental measurements: from the mesial aspect of the first molar to the distal aspect of cuspids, from the distal aspect of the cuspids to the distal aspect of central incisors on both left and right sides, and from the distal aspect of the right central incisors to the distal aspect of the left central incisors (Figure 1F).
- Palatal measurements:
  - i. Palatal depth: the vertical distance at the mid-palatal suture measured the level of the first molars and canines by adjusting a metal ruler on the occlusal surface of the first molars when the ruler touches the mesiobuccal cusp tip as the molar depth (MD) (Figure 1E) and measuring the distance from

the horizontal plane touching the tips of the right and left canines and the midpalatal suture as the canine depth (CD)

ii. Palatal length: this was measured from the anterior part of the palate, which is from the linear contact point of the maxillary central incisors, (a), to the posterior part of the palate which is the most distal point of the maxillary permanent molars (b) (Figure 1D).

iii. Palatal width: the palatal width was measured from the maxillary first molars of one arch to the opposite arch, at the level of the edge of the palatal gingival sulcus (Figure 1C).

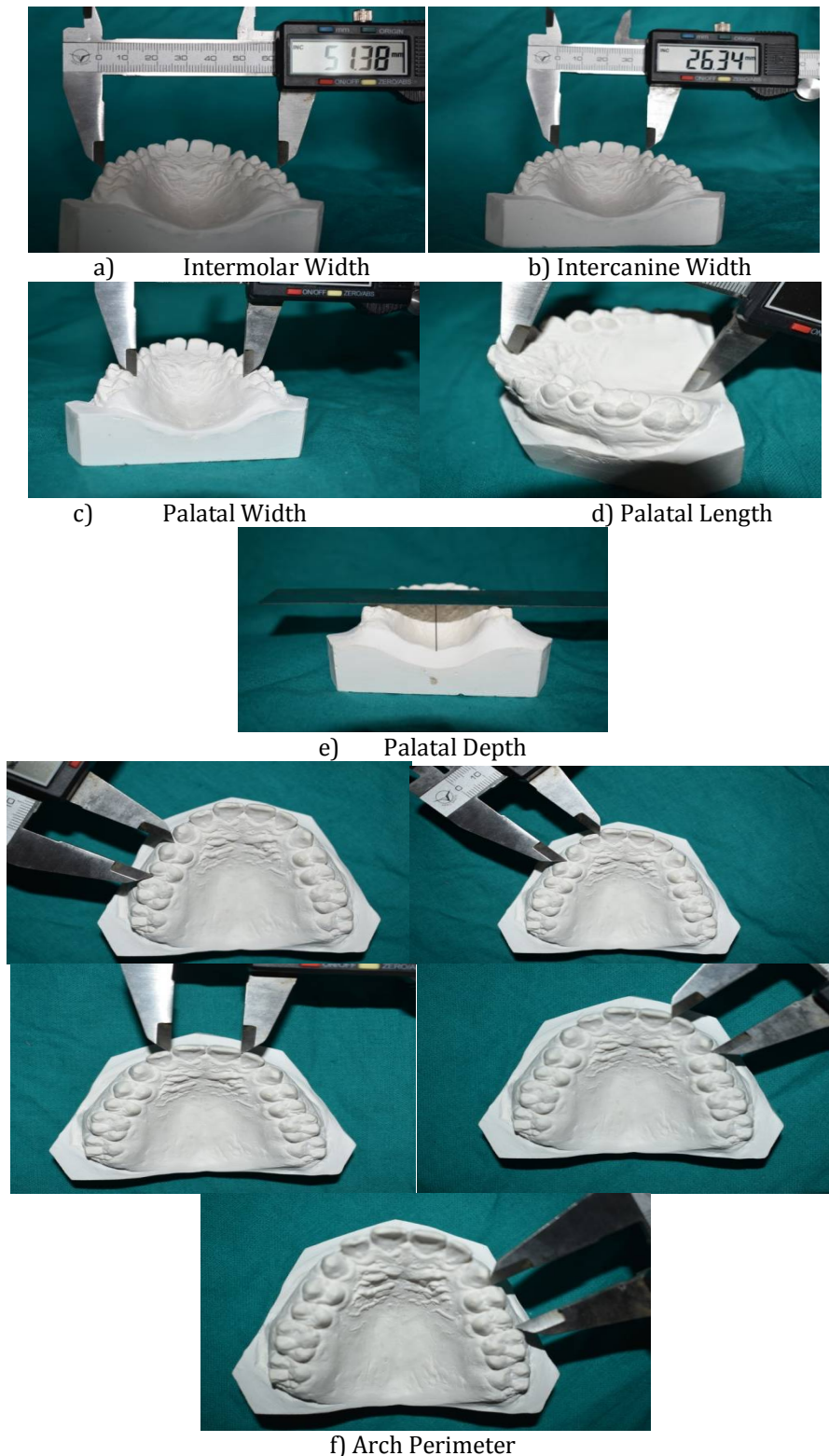


Figure 1 :- Maxillary arch and palatal measurements

Indices:

1. Palatine Height Index (PHI): In order to assess the height of the palate at the molar, The calculation was performed using the PHI formula below:

$$\frac{\text{Palatal Height}}{\text{Palatal Width}} \times 100$$

Index of Palatine Height Formula =

On the basis of the above formula and according to the study performed by Maria CM, the palatal depth was categorized into three types, which were as follows

- a. Low palate: if the values were  $\leq 27.9\%$ .
- b. Medium palate: if the values ranged between 28.0 and 39.9%.
- c. High palate: if the values were greater than 40.0%.

2. Arch Form Index (AFI): the arch form for all study casts was determined by measuring each of the inter-canine width (ICW), CD, inter-molar width (IMW), and molar depth (MD). Based on these observations, the arch form ratio was calculated depending on the AFI formula as illustrated in the following equation.

$$\frac{\text{CD}}{\text{ICW}} \times \frac{\text{IMW}}{\text{MD}}$$

Arch Form Index Formula =

Each cast was then classified into three categories, namely square, ovoid, and tapered, derived from their ratio as explained below. Arch form ratio was obtained in accordance to the study by Budiman in :

- a. Arch form ratio is
  - b. Arch form ratio is between 45.30 and 53.37%, which means oval arch form.
  - c. Arch form ratio is more than 53.37%, which means tapered arch form.
2. Palatine Index (PI): it was calculated through the use of the specific formula adopted by Khatiwada et al..

$$\frac{\text{Palatine width}}{\text{Palatine length}} \times 100$$

Palatine Index Formula =

PI means the ratio of the palatine width to the palatine length which is expressed as a percentage.

- (a) If PI is less than 79, the palate is narrow (Leptostaphyline).
- (b) If PI is between 80 and 84.9, the hard palate is intermediate in width (Mesostaphyline).
- (c) If PI is 85 or more, the hard palate is broad (Brachystaphyline).

Statistical Analysis

Statistical analysis was carried out using statistical packages for IBM SPSS vs 22 for Windows. Independent t test was done to compare different variables. Pearson correlation and multivariate linear regression was done to see association between different variables.

## RESULTS

Statistical analysis was carried out using statistical packages for IBM SPSS vs 22 for Windows. Continuous and categorical variables were expressed as mean  $\pm$  SD. Two sided p values was considered as statistically significant at  $p < 0.05$ . Descriptive statistics was done for different variables in Table 1.

Independent t test was done to compare different variables between male and female (Table 2) Pearsons Correlation was done to see association between arch perimeter and arch form with 3D palatal measurements. (Table 3 and 4). Multivariate linear regression analysis was done to see association between arch perimeter and arch form with palatal measurements. ( Table 5 and 6)

Table 1. Descriptive statistics of different variables

Variables	N	Minimum	Maximum	Mean	SD
Age	40	14.00	24.00	19.42	3.06
Intermolar width	40	42.00	59.00	53.57	4.56
Intercanine width	40	27.00	47.00	37.05	3.16
Palatal Depth molar	40	15.00	26.00	18.10	2.90
Palatal canine	40	4.00	11.00	8.32	1.81
Palatal length	40	41.00	57.00	48.37	3.72
Palatal width	40	29.00	44.00	37.20	3.60
Archperimeter	40	56.00	93.00	78.87	5.93
Palatine height index	40	36.00	72.00	48.67	9.55
Palatine index	40	65.00	92.00	76.52	6.63
Archform	40	31.00	90.00	67.37	16.36

Table 2. Gender differences of different variables of study sample.

Variables		N	Mean	SD	t value	P value
Intermolar width	Male	19	54.78	5.13	1.610	.117
	Female	21	52.47	3.76		
Inter canine width	Male	19	38.00	3.21	1.850	.072
	Female	21	36.19	2.94		
Palatal Depth molar	Male	19	18.63	3.28	1.088	.284
	Female	21	17.61	2.49		
Palatal canine	Male	19	8.52	1.61	.669	.508
	Female	21	8.14	2.00		
Palatal length	Male	19	48.57	4.22	.322	.750
	Female	21	48.19	3.31		
Palatal width	Male	19	38.10	4.13	1.511	.141
	Female	21	36.38	2.90		
Archperimeter	Male	19	79.89	4.65	1.055	.299
	Female	21	77.95	6.87		
Palatine height index	Male	19	49.31	11.34	.392	.698
	Female	21	48.09	7.84		
Palatine index	Male	19	78.00	7.89	1.323	.196
	Female	21	75.19	5.07		
Archform	Male	19	66.47	15.90	-0.329	0.744
	Female	21	68.19	17.12		

Independent t test ; $p > 0.05$  not significant

The above table shows no statistically significant ( $p > 0.05$ ) difference in any of the variable between males and females, although the values were lesser in females as compared to males.

Table3. Correlation of 3D palatal measurements with Arch Form

Palatal Measurements	Correlation with Arch Form	
Palatal Depth molar	r value	-0.566
	p value	<b>&lt;0.001**</b>
Palatal Depth canine	r value	0.709
	p value	<b>&lt;0.001**</b>
Palatal length	r value	0.345
	p value	<b>0.029*</b>
Palatal width	r value	0.296
	p value	0.064
Palatine height index	r value	-0.635
	p value	<b>&lt;0.001**</b>
Palatine index	r value	0.017
	p value	0.916

Pearsons Correlation; \* $p < 0.05$  significant; \*\* $p < 0.001$  highly significant

A negative correlation was seen between palatal molar depth , palatine height index and Archform. A positive correlation seen between palatal canine depth , palatal length and Arch form. No statistical significant correlation was seen with palatal width and palatine index.

Table 4. Correlation of 3D palatal measurements with Arch Perimeter

Palatal Measurements	Correlation with Arch Perimeter	
Palatal Depth molar	r value	-0.085
	p value	0.600
Palatal Depth canine	r value	0.694
	p value	<b>&lt;0.001**</b>
Palatal length	r value	0.578
	p value	<b>&lt;0.001**</b>
Palatal width	r value	0.417
	p value	<b>0.007*</b>
Palatine height index	r value	-0.273
	p value	0.088
Palatine index	r value	-0.069
	p value	0.671

Pearsons Correlation; \* $p < 0.05$  significant; \*\* $p < 0.001$  highly significant

A positive significant correlation was seen between palatal canine depth , palatine length, palatal width and Arch perimeter ,whereas no statistical significant correlation was seen with palatal width and palatine index.

Table 5. Multiple Regression analysis of Arch perimeter (as dependent variable) and palatal variables

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Palatal Depth molar	-.014	.214	-.007	-.067	.947
Palatal Depth canine	1.929	.333	.591	5.796	<b>&lt;0.001**</b>
Palatal length	.683	.204	.429	3.348	<b>0.002*</b>
Palatal width	.035	.203	.021	.173	.864

Palatal canine depth shows highly significant association , palatal length shows significant association, whereas no significant association with palatal molar depth and palatal width seen with Arch perimeter.

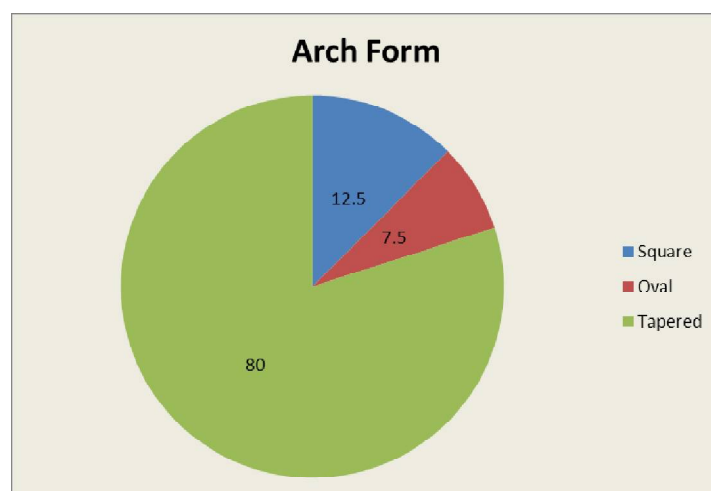
Table 6. Multiple Regression analysis of Arch form (as dependent variable) and palatal variables

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Palatal Depth molar	-3.645	.322	-.648	-11.320	<b>&lt;0.001**</b>
Palatal Depth canine	6.560	.501	.728	13.091	<b>&lt;0.001**</b>
Palatal length	-.460	.307	-.105	-1.499	0.143
Palatal width	.841	.305	.185	2.755	<b>0.009*</b>

Palatal molar depth and palatal canine depth shows highly significant association, palatal width shows significant association with Arch form, whereas no significant association seen with palatal length and Arch form.

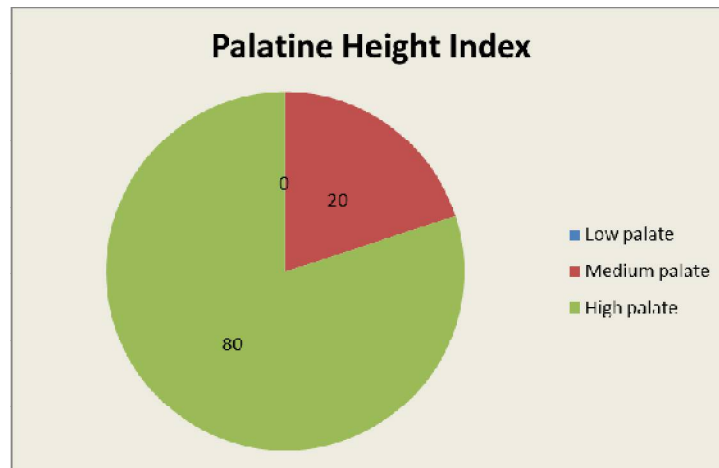
Table no.7 Frequency and percentage of different variables of the study sample

Variables		N	%
Gender	Male	19	47.5
	Female	21	52.5
Arch Form	Square	5	12.5
	Oval	3	7.5
	Tapered	32	80.0
Palatine Height Index	Low palate	0	0
	Medium palate	8	20.0
	High palate	32	80.0
Palatine Index	Narrow	27	67.5
	Intermediate	10	25.0
	Broad	3	7.5

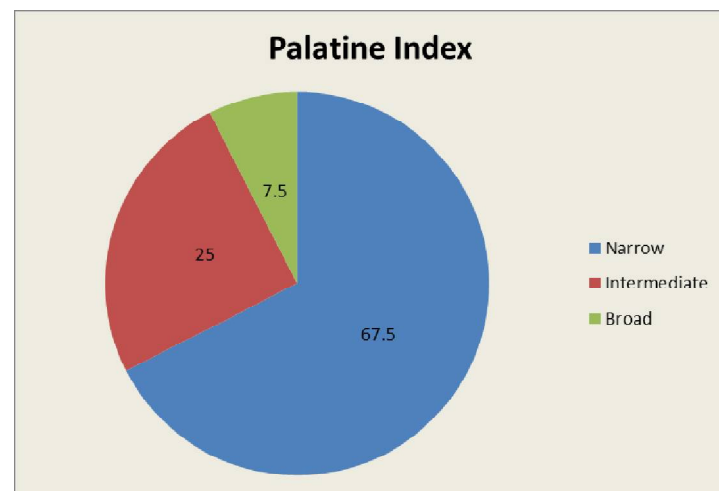


Graph No. 1 Frequency of arch form among study subjects





Graph No. 2 Frequency of palatine height among study subjects



Graph No. 3 Frequency of palatine index among study subjects

## DISCUSSION

Exact assessment of the hard palate provides many clinical considerations, notably in various disciplines such as orthodontics, orthognathic surgeries, palatal implants, cleft palate management, and treatment of obstructive sleep apnea [8]. Different populations and ethnic groups exhibit variable dental arch dimensions and characteristics, encouraging researchers worldwide to document dental arch dimensions and forms in several populations and races [9]. The study depends on the important aspect of establishing a set of norms on various arches, and palatal parameters present significant clinical considerations in various disciplines in dentistry. The arch form norm of the population probably facilitates the selection of arch wires during orthodontic treatment courses, for instance.

An increase in dental arch dimensions occurs at up to 9 years in the incisor region, whereas it may reach 13 years of age in the other regions of the dental arch. Then, after that age, little change occurs [10]. This is why the age range of the present sample study included 16–24-year-old orthodontic patients.

Study casts were selected as a raw material for conduction of the study as it can offer much information about the intended case, and it has also many advantages, such as determination of space available and required calculation, arch widths, lengths, and perimeters, with the aid of digital Vernier as analyzing software [13].

All of the subjects who participated in the current study had a high and narrow type of palate. In regard to arch form, most of the subjects have tapered arch form.

1. Palatal width: the mean of the palatal width was  $37.20 \pm 3.60$  mm in our study; Khatiwada *et al.*<sup>14</sup> in 2020 did a study on a Nepalese population and stated that the mean palatal width was  $40.63 \pm 3.76$  mm. Mustafa *et al.*, in a similar study on Jordanians, found it to be  $45.05 \pm 2.47$  mm in males and  $40.23 \pm 2.01$  mm in females. Similarly, Annapurna *et al.*[9] showed that the average palatal width was  $38.2 \pm 03.2$  mm in 60 patients in India attending a government hospital. Accordingly, the mean palatal width of the

current study sample was less than all the studies done before suggesting a narrow arch in Chhattisgarh population.

2. Palatal length: the mean palatal length of the present study was  $48.37 \pm 3.72$  mm. It was found to be  $41.58 \pm 3.48$  mm in a Nepalese population by Khatiwada *et al.* [14]. Mustafa *et al.*, [10] who examined 150 dental casts of adult persons found the mean palatal length to be  $43.91 \pm 2.65$  and  $39.53 \pm 2.73$  mm, respectively, and reported significant gender differences. Moreover, it was  $51.4 \pm 5.8$  mm,  $51.65 \pm 4.7$  mm,  $50.82 \pm 3.59$  mm,  $43.54 \pm 0.28$  mm, and  $49.74$  mm in studies carried out by Klosek *et al.*, Shalaby *et al.*, Dave *et al.*, and Jotania *et al.* respectively [10-11]. Significant gender dimorphism was not observed in our study with increased dimension for males, whereas Ahmed *et al.* [12] found no significant sex differences in respect to palatal length which were in controversy with the findings of Khatiwada *et al.* [14], who reported longer palates in females when compared to males. Accordingly, the mean palatal length of the current study sample was more than all the studies done before suggesting a longer palates in Chhattisgarh population.

3. Palatal depth: the mean palatal depth in the molar area was  $18.10 \pm 2.90$  mm in our sample. It was  $14.90 \pm 2.05$  mm and  $20.76 \pm 3.1$  mm by Khatiwada *et al.* [13] and Alshahrani *et al.* [14] respectively.. Klosek *et al.* [17] found it to be  $17.7 \pm 4.2$  mm,  $9.87 \pm 0.23$  mm, and  $13.1 \pm 2.7$  mm, respectively. Another study on the Kenyan African skull by Hassanali *et al.* palatal height was  $12.2 \pm 0.6$  mm [18].

Accordingly, the mean palatal depth of the present study was more than all previously mentioned studies from different parts of the world identifying deeper palate in a Chhattisgarh sample. No significant gender difference was reported in palatal height in the molar area in the present study. Similar results were acquired on an Iranian population. Furthermore, Tsai and Tan demonstrated no gender differences. On the contrary, Al-Zubair and Thalider showed that palatal height in the molar site was greater in females than in males. This contradiction could be attributed to ethnic differences among studied populations. Generally, differences in palatal measurements have been encountered in the literature among individuals with respect to growth pattern of facial region, environmental and genetic background, and pathologies such as enlarged tonsils, nasal allergies, or prolonged mouth breathing [15]. Although controversies were reported by different investigators about gender differences of palatal measurements, the findings of the current study displayed higher values in all measured dimensions in males compared to females.

4. Arch form: In regard to arch form, the tapered maxillary arch form was the most frequent type, followed by an square arch form followed by oval arch form observed in the current study. The oval maxillary arch form dominates in the Sudanese population [16]. A recent Saudi study found the most prevalent arch form to be the narrow tapered followed by the narrow ovoid. The tapered arch shape was the most prevalent maxillary arch form in both the Indian and the Malaysian population. In an Indian sample, the majority of them had tapered arch form, and the remaining had ovoid arch form, without any squared maxillary arch form. While in the Malaysian population, although the majority of them had tapered arch form, there were only some with oval maxillary arches and few with squared arch form. In another study on the Malaysian population [17] the ovoid maxillary arch form was the greatest, followed by tapered and then square. It was stated that Indian people tend to have a narrow arch form in a study performed by Sahoo *et al.* [18]

3. Arch Perimeter: With reference to what was stated in the results, all dimensions of the palate except palatine width were significantly associated with the arch perimeter. On the other hand, a strong correlation of arch perimeter was reported with palatal canine depth and a medium correlation with palatal length. On the contrary, no significant correlation between the arch perimeter and the depth of the palate and a significant correlation of the arch perimeter with palatal width was found in a study done by Eid *et al.* [8] on Egyptians. Furthermore, in another study on the Iraqi population by Salman in 2001 [19] no correlation was found between arch perimeter and palatal depth. At the same time, a moderate correlation of maxillary perimeter with palatal width was demonstrated by Salman in 2001 which was in concordance with the present study. Different ethnic groups, sample size, different landmarks, and measurement devices with a different age group of the study sample may be behind these controversies. Expansion of the present study is recommended and suggested by the authors to a larger study to set norms for palatal and arch dimensions to reflect the characteristics of the Chhattisgarh population.

## CONCLUSION

Most of the subjects had narrow and high type of palate with tapered arch form. Positive correlation was seen between arch perimeter and palatal canine depth, palatal length and width. Negative correlation was seen between palatal molar depth, palatine and Arch form. Positive correlation seen between palatal canine depth, palatal length and Arch form.



## REFERENCES

1. Fadil A. Kareem , Aras Maruf Rauf, Tara Ali Rasheed , and Falah Abdullah Hussain. (2021).Correlation of Three Dimensions of Palate with Maxillary Arch Form and Perimeter as Predictive Measures for Orthodontic and Orthognathic Surgery. *Children* 8, 514.
2. SalwaAbd El Samad Younes. (1984).Maxillary arch dimensions in Saudi and Egyptian population sample. *Am. JOrthod.* 12, 34-39.
3. Ayman G. Mustafa ,Ayssar A. Tashtoush, Othman A. Alshboul , Mohammed Z. Allouh, and Ahmad A. Altarif. Morphometric Study of the Hard Palate and Its Relevance to Dental and Forensic Sciences. *International Journal of Dentistry*. DOI:10.1155/2019/1687345
4. Fadil Abdullah Kareem , Aras Maruf Rauf , Arass Jalal Noori , and Trefa M. Ali Mahmood. Prediction of the Dental Arch Perimeter in a Kurdish Sample in Sulaimani City Based on Other Linear Dental Arch Measurements as a Malocclusion Preventive Measure. *Computational and Mathematical Methods in Medicine*. <https://doi.org/10.1155/2020/8869996>
5. Marcus M. Dager; James A. McNamara; TizianoBaccetti; Lorenzo Franch. (2008). Aging in the Craniofacial Complex. *Angle Orthodontist*, Vol 78, No 3, 20-26
6. Haider M.A. Ahmed, a Noor F.K. Al-Khawaja, a and Mohammed Nahidh. (2014). Assessment of Palatal Dimensions in a Sample of Iraqi Adults with Different Facial Forms. (*Iraqi Orthod J* ; 10(1): 8-11.
7. Maria, C.M.; Silva, A.M.; Busanello-Stella, A.R.; Bolzan, G.P.; Berwig, L.C. (2013). Palatodural depth assessment: Correlation between quantitative and qualitative methods. *Rev. CEFAC* , 15, 1292-1299
8. Eid, A.; El-Namrawy, M.; Kadry, W. (1987). The relationship between the width, depth and circumference of the dental arch for a group of Egyptian school children. *Egypt. Orthod. J.* 1, 113-136.
9. Mahdi, E. (2012). Assessment of Facial and Cranial Development and Comparison of Anthropometric Ratios. *J. Craniofac. Surg.* , 23, e75-e83
10. Manjunath, T.H.; Kuppast, N.C.; Umesh, S.R.; Iddalgave, S. (2014). Identification of Gender from Dimensions of Palate. *Med. Legal Updat.* 14, 132
11. Carter, G.A.; McNamara, J.A.(1998). Longitudinal dental arch changes in adults. *Am. J. Orthod. Dentofac. Orthop.*, 114, 88-99.
12. Knott, V.B. (1972). Longitudinal study of dental arch widths at four stages of dentition. *Angle Orthod.* 42, 387-394.
13. Proffit, W.R.; Fields, H.W.; Larson, B.; Sarver, D.M. (2019). *Contemporary Orthodontics*, 6th ed.; Elsevier: Amsterdam, The Netherlands.
14. Khatiwada, S.; Chaulagain, R.; Khan, G.A.; Mishra Sapkota, S.; AdhikariSudhin, B.N. (2020). Morphometric Analysis of Hard Palate on Nepalese Population. *J. Karnali Acad. Health Sci.* 3, 9. 123-126
15. Annapurna, P.; Pushyami, P. (2019). A study on hard palate and high arched palate: A morphometric study with associated traits. *Int. J. Anat. Res.* , 7, 6657-6662.
16. Mustafa, A.G.; Tashtoush, A.A.; Alshboul, O.A.; Allouh, M.Z.; Altarifi, A.A. (2019). Morphometric study of the hard palate and its rel-evance to dental and forensic sciences. *Int. J. Dent.* , 2, 1-6.
17. Klosek, S.K.; Rungruang, T. (2009). Anatomical study of the greater palatine artery and related structures of the palatal vault: Considerations for palate as the subepithelial connective tissue graft donor site. *Surg. Radiol. Anat.*, 31, 24550.
18. Dave, M.R.; Gupta, S.; Vyas, K.; Joshi, H.G. A (2013). Study of Palatal Indices and Bony Prominences and Grooves in the Hard Palate of Adult Human Skulls. *NJIRM* , 4, 7-11.
19. Jotania, B.; Patel, S.; Patel, S.; Patel, P.; Patel, S.; Patel, K. (2013).Morphometric analysis of hard palate. *Int. J. Res. Med.* 2, 72-75

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