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# A Comparative study between facial growth pattern and dental arch width and form in regional population –an in vitro study

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## ABSTRACT

**Introduction-** It is generally accepted among orthodontists that a relationship exists between vertical facial morphology and the cant of mandibular plane. A subject with a high SN – MP angle (SN- Sella to Nasion and MP-mandibular plane) tends to have a longer face and one with a low SN – MP angle (flat MP) often has a shorter face. Materials and methods- This study includes lateral cephalograms and study models of untreated 75 males and 75 females (between age group 18-30 years) from regional population. Cephalometric analysis- SN-MP angle, study model analysis- inter molar, inter premolar, and inter canine width. Arch form-Ovoid, tapered and square arch forms were made with 0.016 ss wire with the help of template for maxillary and mandibular arches of males and females. Result-samples with SN-MP angle $<27^0$ shows wider arches and the samples with SN-MP angle $>37^0$ showed narrow arch in male and female. Inter canine & inter molar width is more in males than females. & the preformed arch form was wider than the inter canine, inter first and second premolars & inter molar width. Conclusion- SN-MP angle is inversely proportional to the arch width. Hyperdivergent facial types tend to have narrow arch forms, Hypodivergent facial types tend to have wider arch forms in male and females. Males have wider arch width than females, this suggests to utilize customized arch wires for different facial growth patterns, pre- treatment arch form and width.

**Keywords-**SN – MP angle, hyperdivergent, hypodivergent**.**

## INTRODUCTION

Relationship between vertical facial morphology and the cant of the mandibular plane is universally known & accepted among orthodontists . A subject with a high SN – MP angle (SN- Sella to Nasion and MP-mandibular plane) will show a tendency to have a longer face and those with a low SN – MP angle (flat MP) usually has a shorter face [1]. It is characterised that a individual having more facial height will usually exhibits narrower transverse dimensions (dolichofacial) and a individual having shorter facial height will show wider transverse dimensions (brachyfacial)[2,3]

Clinically, preformed arch wires are routinely used by many orthodontists regardless of the facial type of the patients. The purpose of this study is to investigate the maxillary and mandibular arch width and form in untreated male and female subject with low, average, and high mandibular plane angle, in relation to facial growth patterns. This will help in utilizing particular arch wires for different facial growth patterns and associated arch forms for regional population.

This study includes lateral cephalograms and study models of untreated 75 males and 75 females (between age group 18-30 years) from regional population .The subjects are included as per inclusion and exclusive criteria.

## METHODS AND MATERIALS

## INCLUSION CRITERIA

- Skeletal and dental class I relationship bilaterally.
- Minor spacing or crowding.

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- Permanent dentition with or without third molars.
- Pleasant profile.

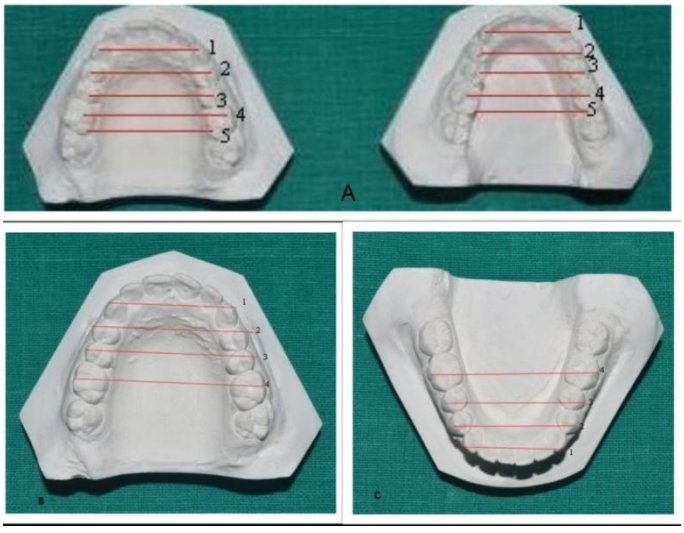
**EXCLUSION CRITERIA**

- History of previous orthodontic treatment.
- History of extractions.
- Missing teeth.
- Previous facial trauma.
- Attrition .
- Massive restorations and prosthetics.
- Anterior and posterior cross bite.
- Gingival inflammation.
- Gingival recession.

## METHOD

### (A) Arch width-

Upper and lower arch alginate impressions were made for study models of each
Subject and following measurements were performed on maxillary and mandibular cast using a digital calliper accurateto 0.01 mm.
1. Inter-canine width, First and second inter-premolar widths, First inter-molar widths [(buccal cusp tip and central fossa) (fig1 )].
2. Inter-canine width, First and second inter-premolar widths, First inter-molar widths. [(most widest buccle aspect and narrowest lingual aspect) ,(fig 1 )].



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Figure 1-. A- 1- Intercanine width from canine tip. 2 Inter first premolar width from central groove .3 Inter second premolar width from central fossa.4 Inter first molar width central fossa. 5 Most lingual inter first molar width B- Most buccal inter canine width. 2. Most buccal inter first premolar width. 3. Most buccal inter second premolar width. 4. Most buccal inter first molar width in maxillary arch **C**- Most buccal inter canine width . 2. Most buccal inter first premolar width. 3. Most buccal inter second premolar width. 4. Most buccal inter first molar width in mandibular arch

**(B)Arch form –**

Ovoid, tapered and square arch forms were made with 0.016 ss wire with the help of template for maxillary and mandibular arches of males and females. Canine, first premolar, second premolar, and first maxillary and mandibular molars were marked on the arch wire with marker pen. The following measurements were taken on the formed 0.016 inch stainless steel arch form with Vernier caliper.(fig 2)

1. Inter-canine width
2. First and second inter-premolar width
3. First inter-molar width

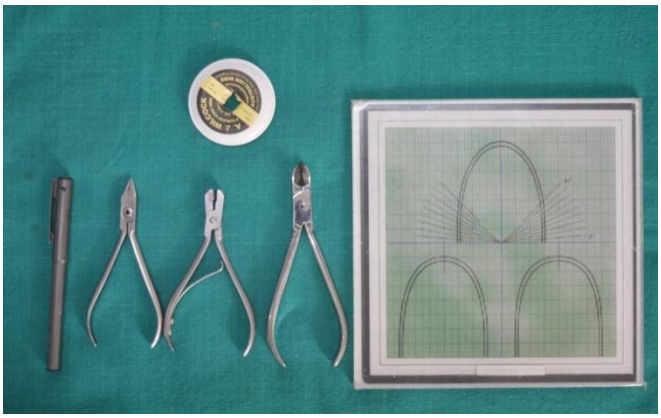


Figure 2- Arch form template, arch forming plier, bird beak plier, hard wire cutter,0.016AJWilcock wire, Marking pen.

**(C)** Lateral Cephalogram of 150 patients were taken in natural head position in oral radiology department , using a standardized and specified technique and study models were made for each individual .

Lateral cephalogram of the patients reporting to the department were used. Cephalogramare traced on .003 inch acetate tracing paper with 0.5mm lead pencil by a single operator. Randomly 50(25males and 25 females) cephalogram were traced thrice and average reading is considered in order to assess landmark location error. The following Cephalometric measurements are used to assess the facial growth pattern and dental arch width and form.

**Cephalometric landmarks – fig 3**

**Sella (S) -** geometric center of the pituitary fossa located by visual inspection.
**Nasion (N)** – located at the most anterior aspect of the frontonasal suture.
**Gonion (Go) –**using two lines, one tangent to inferior border of mandible and other tangent to the posterior border of ramus, Gonion is located on the curvature of mandibular angle by bisecting the angle formed by two lines.

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**Menton (M)** – using a line parallel to Frankfort horizontal plane, move the straight edge upward until it first touches the inferior border of symphysis of mandible;the potnt is marked as menton
**Statistical analysis:** Two variables were measured and tabulated (Annexure) and statistically analyzed using analyzed by using SPSS 19.0 version IBM USA software to get their interpretations. Mean ,standard deviation, standard error of mean and P value were calculated for each parameter. 't' Test, One way ANOVA, Tukeys Post Hoc test

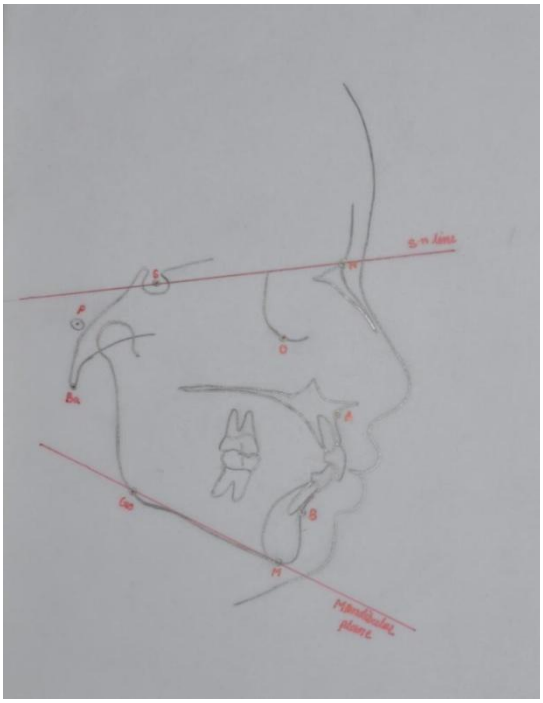
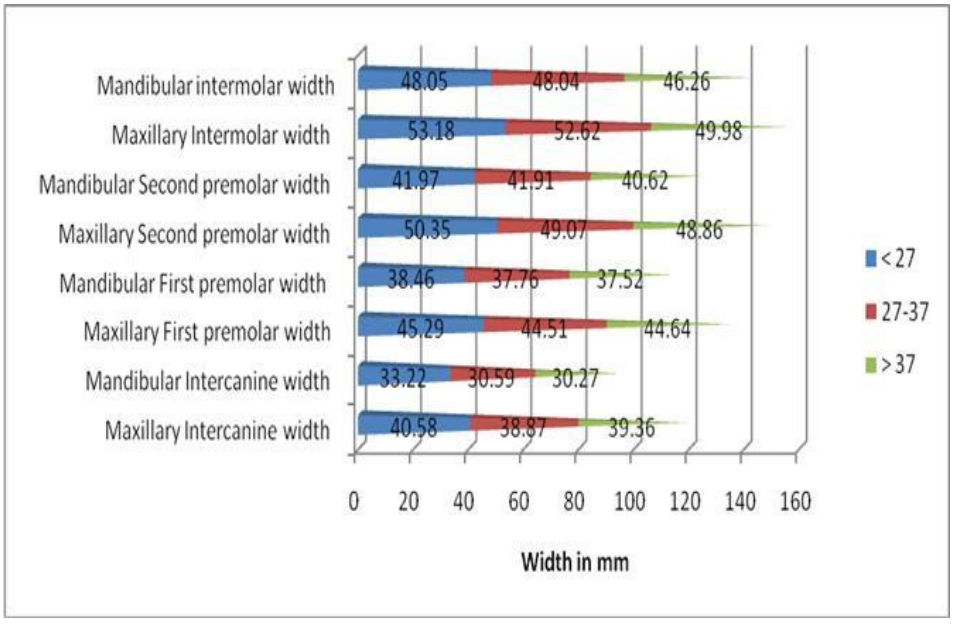


Figure 3- Lateral cephalogram tracing with SN-MP plane.

## Results

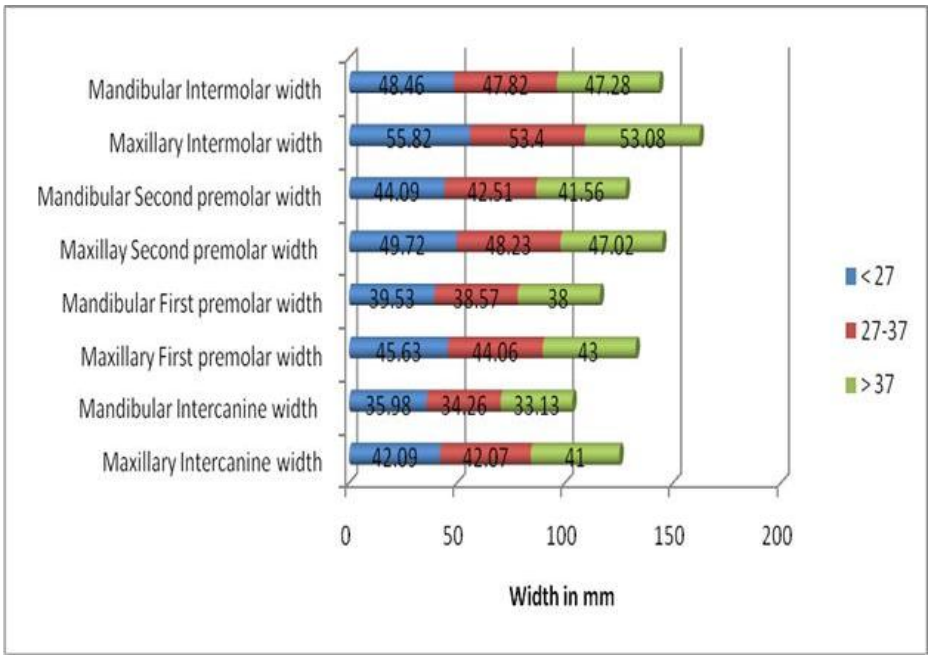



**Graph 1- Comparison between arch width and SN-MP angle in females.**

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**Graph no 1** shows comparison between SN-MP angle and arch width in male. High SN-MP angle samples have narrow arches and low SN-MP angle samples have wide arches




**Graph 2 - Comparison between arch width and SN-MP angle in males.**

**Graph no 2** shows comparison between SN-MP angle and arch width in female. High SN-MP angle samples have narrow arches and low SN-MP angle samples have wide arches

**TABLE 1- Comparisons between males and females arch width**

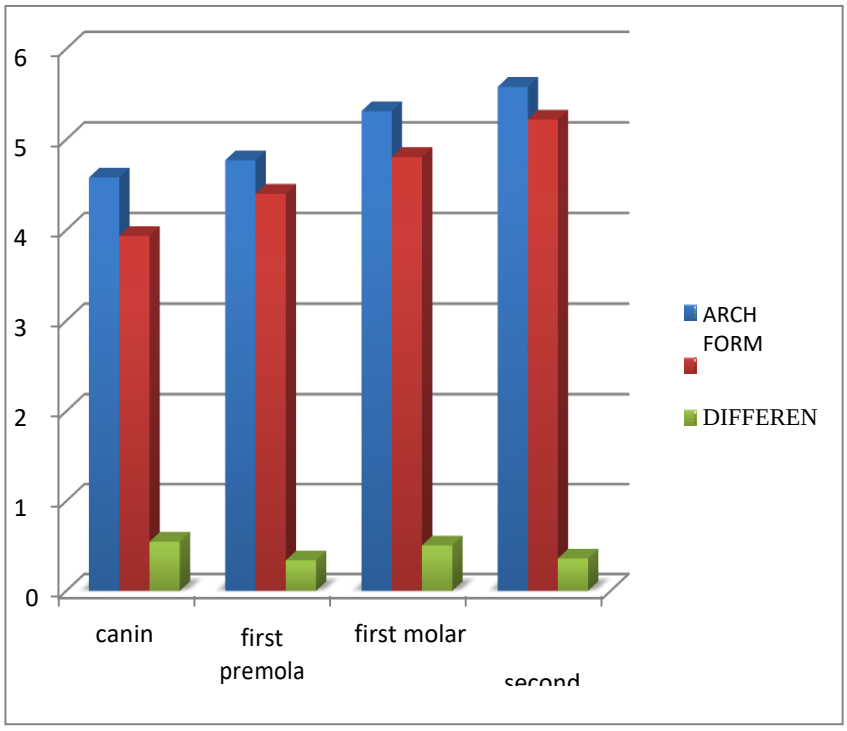
| | Groups | N | Mean | Std. Deviation | T | df | P | Inference |
|---|---|---|---|---|---|---|---|---|
| **maxillary archInter canine width** | Males | 75 | 42.00mm | 2.68 | 5.980 | 148 | .0001 | Highly significant |
| | Females | 75 | 39.36mm | 2.73 | | | (<0.001) | |
| **Inter canine mandibular arch width** | Males | 75 | 34.03mm | 3.49 | 4.598 | 148 | .002 | Significant |
| | Females | 75 | 31.35mm | 3.64 | | | (<0.05) | |
| **maxillary archFirst premolar width** | Males | 75 | 44.78mm | 3.79 | 2.404 | 148 | 0.048 | significant |
| | Females | 75 | 44.00mm | 2.56 | | | (>0.05) | |
| **mandibular** | Males | 75 | 38.91mm | 2.68 | 2.217 | 148 | .02 | Significant |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **arch interFirst premolar width** | Females | 75 | 37.72mm | 3.82 | | | (<0.05) | |
| **maxillary arch inter Second premolar width** | Males | 75 | 49.21mm | 3.03 | 2.619 | 148 | .036 | significant |
| | Females | 75 | 48.06mm | 3.42 | | | (>0.05) | |
| **mandibular arch inter Secind premolar width** | Males | 75 | 43.18mm | 3.76 | 2.933 | 148 | .048 | significant |
| | Females | 75 | 41.10mm | 2.51 | | | (>0.05) | |
| **maxillary arch inter First molar width** | Males | 75 | 54.29mm | 3.48 | 2.307 | 148 | 0.019 | significant |
| | Females | 75 | 52.20mm | 3.15 | | | (>0.05) | |
| **mandibular arch inter First molar width** | Males | 75 | 48.52mm | 3.07 | .2.41 | 148 | .0.041 | significant |
| | Females | 75 | 47.52mm | 3.74 | | | (>0.05) | |

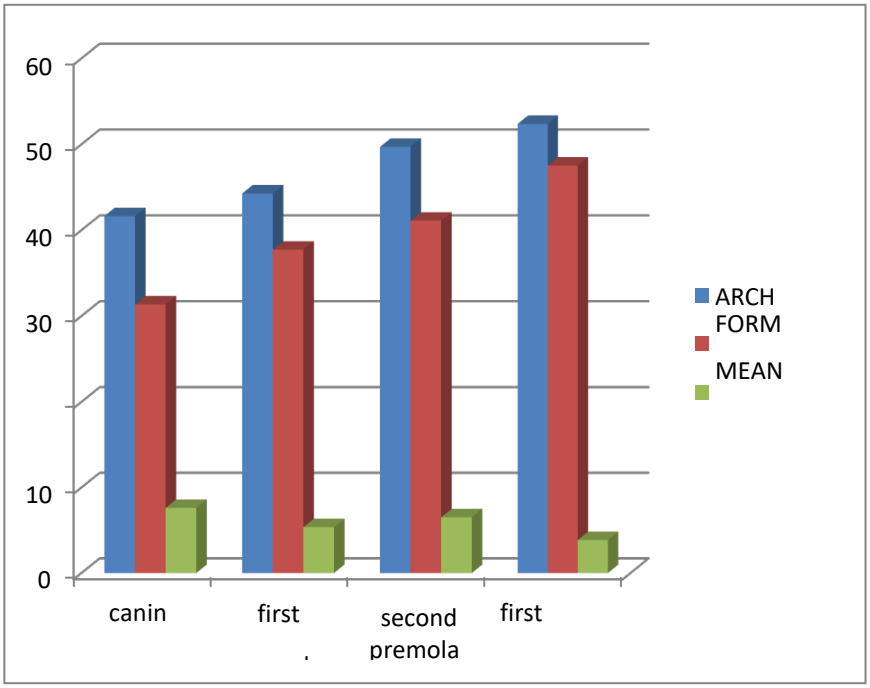
**Table no 1** Shows significance difference between male and females with maxillary and mandibular inter-canine width measured from most buccal and from the tip, maxillary and mandibular inter first pre-molar width from most buccal and cusp tips, maxillary and mandibular inter-second molar width from most buccal and cusp tips, and maxillary and mandibular inter- first molar width measured from most lingual, from the central fossa and most buccal surface of males and females. The maxillary inter canine width (P value**.0001)** shows highly significance in both males and females.

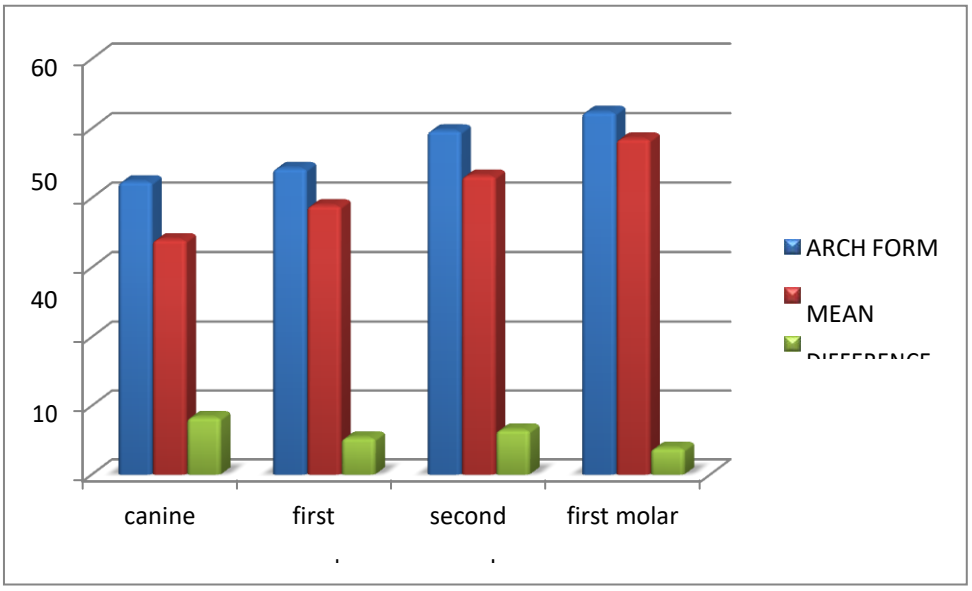


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**Graph 3- Comparison between ovoid arch form & maxillary arch female**



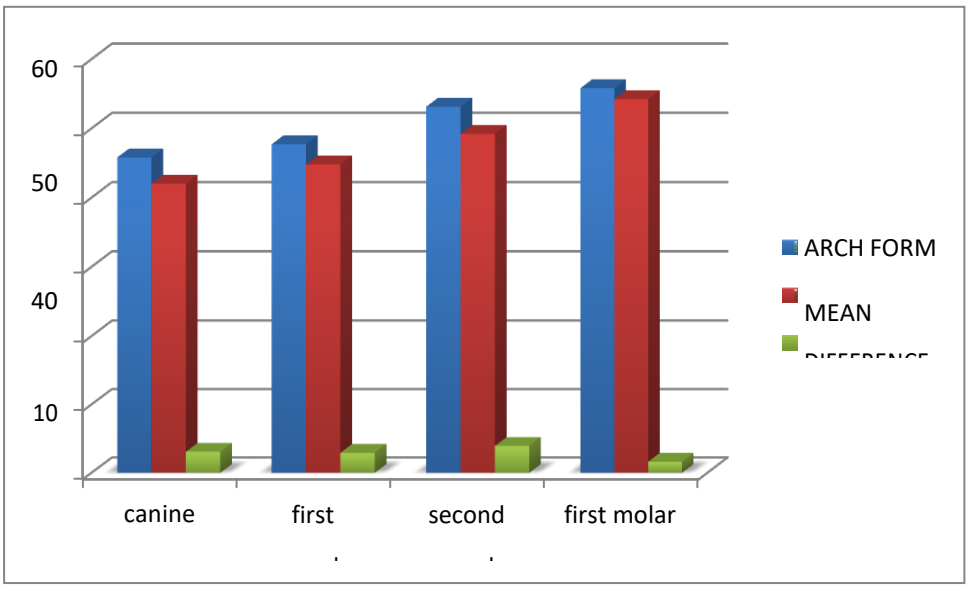




**Graph 4- Comparison between ovoid arch form & mandibular arch female.**

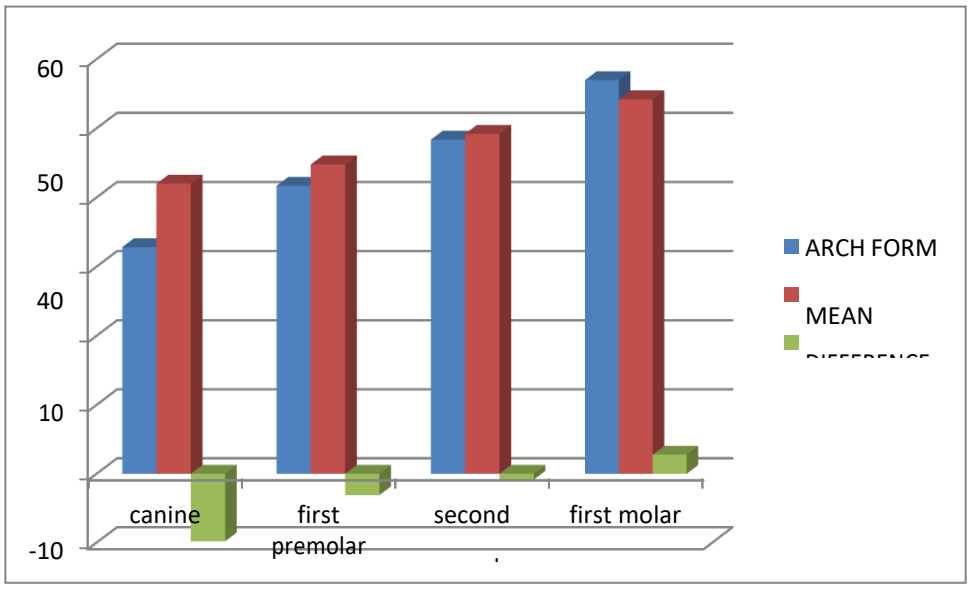
**Graph 5- Comparison between ovoid arch form & mandibular arch –male.**

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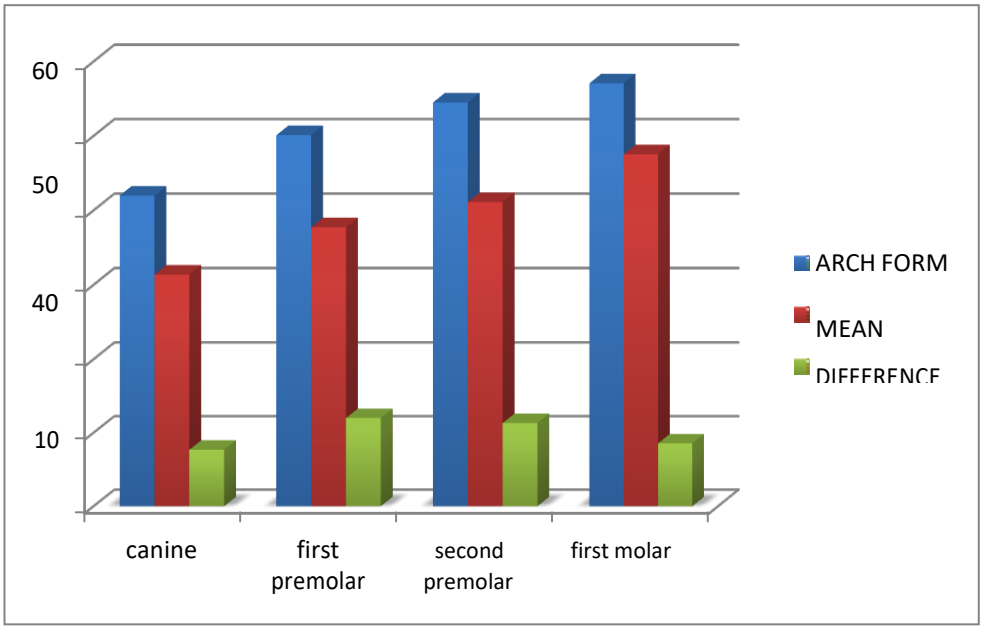

**Graph 6- Comparison between ovoid arch form & maxillary arch - males**



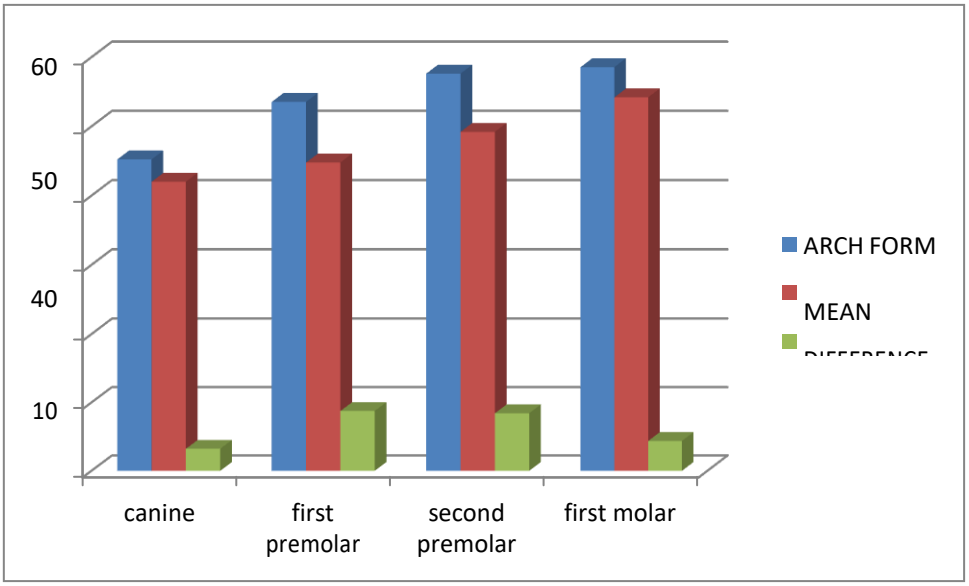

**Graph 7 - Comparison between square arch form & mandibular arch – female.**

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**Graph 8- Comparison between square arch form & maxillary arch female.**




**Graph 9- Comparison between square arch form & maxillary arch – male.**

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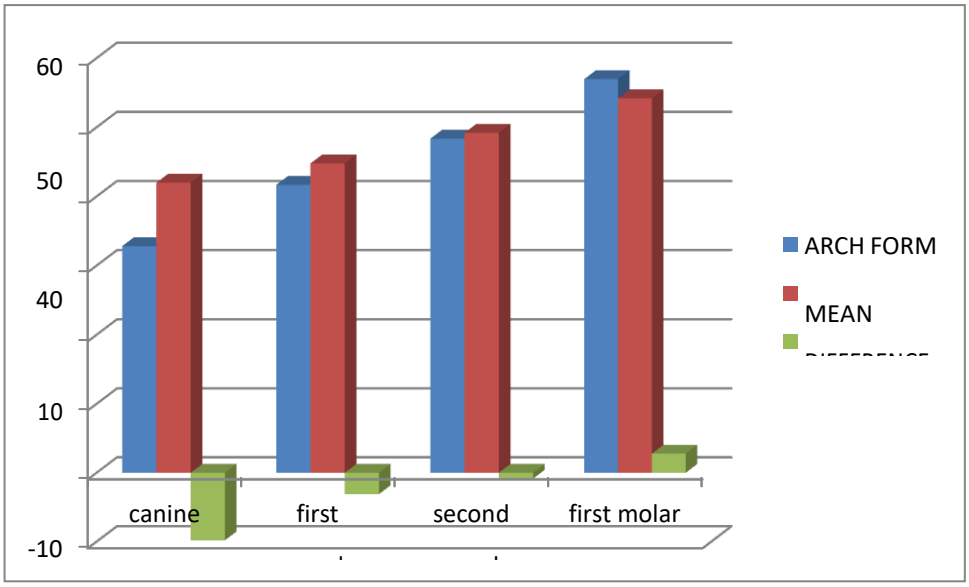
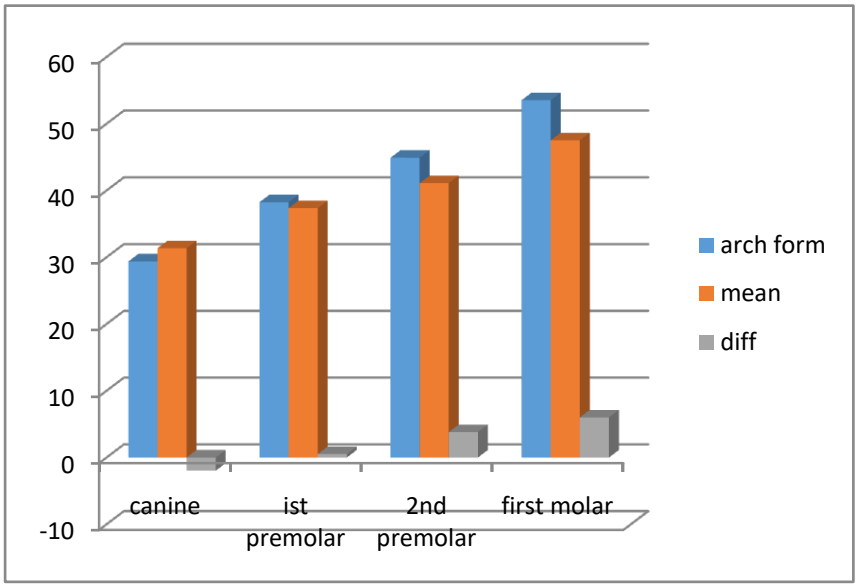


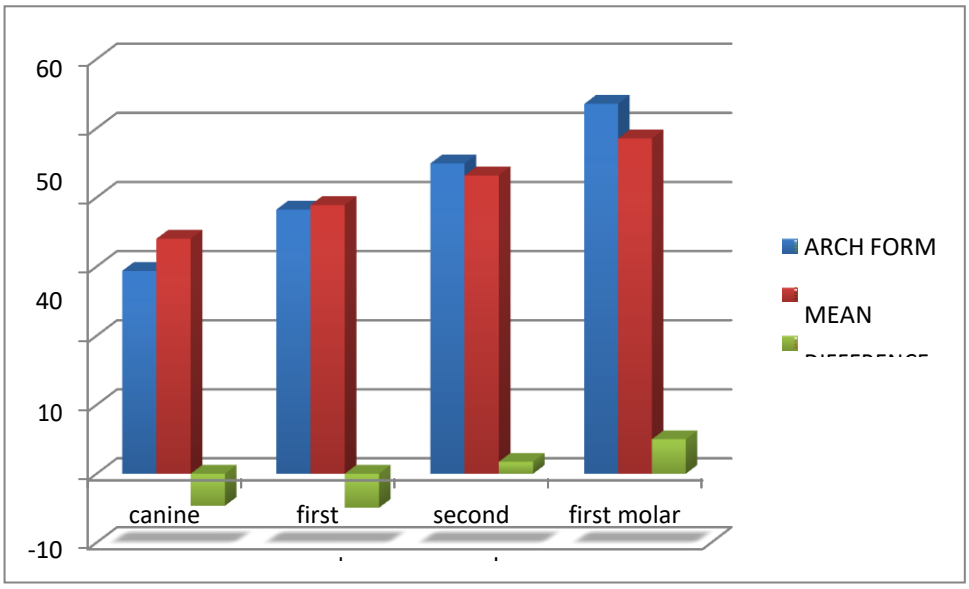

**Table 10 - Comparison between square arch form & mandibular arch – female.**



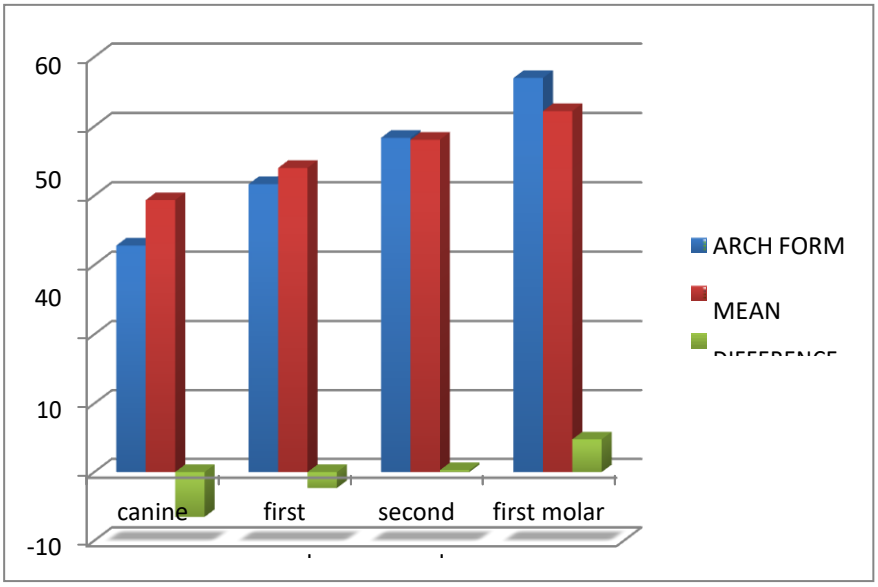

**Graph 12- Comparison between Tapered arch form & mandibular arch – female**

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**Graph 13- Comparison between Tapered arch form & maxillary arch – male**




**Graph 14- Comparison between Tapered arch form & mandibular arch – male**

**Graph no 3-14** Shows the comparison between the mean of male and female maxillary & mandibular arch width and the ovoid,squre,taperd arch form. The formed arch form was wider than the inter canine, inter first and second premolars & inter molar width.

## DISSCUSSION

Facial morphology is unique to every individual in the world. The proportional relationship between facial height and width is the first step in facial evaluation during orthodontic diagnosis. The facial pattern of an individual can be taken into consideration as an important factor that aids in the

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treatment selection and protocol. Since each individual's face has a proportion unique to it, so do the dental arches. The question is whether the shape of the dental arch corresponds to the facial morphology and vice versa[4]. Understanding the facial proportion can be the key to both diagnosis and treatment of an orthodontic patient.

With the increased use of arch wires to correct transverse dimensions of the dental arches the increased knowledge of a link between facial proportion and dental arch width can be of immense help to orthodontists.

This study evaluates adult males and females separately on the bases of

1) Sexual dimorphism in arch width.
2) Correlation between arch width and facial growth pattern.
3) Comparison between preformed arch form and individual arch form.

Measurement of dental arch was not a much explored topic in past as less evidences have found about studies on dental arch and most of these studies were in concern with the relationship between craniofacial anomalies and dental arch or surgical procedures and dental arch[5,6] . Some studies were done on racial and hereditary influences on dental arch measurements.[7,8] The present study included adults of regional population, with no dental abnormalities, this parameters confirms that the samples represents ethnic regional population with same geographical environment. In this present study dental cast and latral cephalograms of 150 samples divided in two groups, 75 males and 75 females were analyzed on the bases of gender difference in arch width and correlation between arch width and facial growth pattern

This present study has confirmed the concept that the male's dental arches are larger than that of female's . Since all of the mean values are larger in male subjects than that of the females and this agrees with Samir Bishara 1996 [9], he stated that males have wider arches and tendency of longer arches; C Matthew foster 2008 [5], he found wider dental arch in males than the females ; Robert T. Lee 1999 [10], has noted that Male arches grow wider than female arches . Sultan Olmez 2011,[11] concluded that boys arch widths and depths were greater as compared with girls .Vishnu Patel et al 2012,[12] concluded that females has greater tendency for narrow arch form, and males has wider arch forms .The weaker muscle function & small ,smooth bony ridges may be one of the reason that the females have narrower arches [6] . According to the functional matrix theory of Melvin Moss (1962) bone grows in influence with the activities or function of surrounding structures( Moss ML 1997)[13]. Considering the theory it could be said that the mechanical stress created by bite force, along with function of some masticatory muscles have some impact on size and shape of adjacent skeletal structures, this could be a answer for difference in arch width and facial pattern in individuals [14]. Helkimo et al 1978 [15], noted that males have greater bite force as compared to females, so we can consider that greater bite force can be responsible for wider arches.

Dental arch width and facial pattern certainly varies with race and ethnicity as well. After analysing the collected data we found highly significant inverse relationship between MP-SN angle and dental arch widths. That means subjects having SN-MP angle $<27^0$ have wider arch with and those who have SN-MP angle $<37^0$ have narrower arch forms. These findings supports the findings of Stephen Wei 1970 [3] stated that the gonial angle was negatively correlated with the bizigomatic width. The results of present study are also in agreement with, Forster et.al 2008[5],Cristina Grippaudo 2013 [16], Gomes et al 2010,[11]

It is commonly accepted that the Musculature has a major impact on the relationship between the transverse and vertical facial dimensions . The conclusions from some studies prove that the masticatory muscles has a great influence on craniofacial growth. Commonly individuals having stronger mandibular elevator muscles will present brachycephalic head shape [5].

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Though the results of the present study suggests an inverse relationship between MP – SN angle and dental arch widths, as the correlation was not very strong so It could be considered that the MP – SN angle might be only one of the contributing factors.

Recently, the trend in treatment has been moved towards more individualized care. Along with this, clinicians should consider relatively large individual variations that are normal. Literature has discussed many geometric and mathematical models of arch forms; it was developed mainly to describe dental arch form more accurately. Chuck (1932)[17] have classified arch forms as tapered, square and ovoid. Many orthodontists and manufacturer have followed this classification over the years. Our results of comparison between samples arch width and the ovoid, tapered and square arch forms shows greater difference. The preformed arch form with the help of template does not match to the individual arch forms of the sample. This finding is supported by various studies done by various authors which states that individual arch form should be used for every patient. [10,18,19,20]

## CONCLUSION

- SN-MP angle is inversely proportional to the arch width.
- Hyperdivergent facial types tend to have narrow arch forms.
- Hypodivergent facial types tend to have wider arch forms.
- No sexual dimorphism observed in SN-MP angle.
- Males have wider arches than females.
- Preformed arch forms are wider than individual arch forms.

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