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RELATING CAREY'S ARCH LENGTH, ARCH FORM AND ARCH ALIGNMENT WITH JARABAK'S RATIO

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Abstract: The facial growth pattern differs from individual to individual and is unique with variations in it. The assessment of relationship of dental arch dimensions with facial growth pattern is essential in Orthodontics for proper diagnosis and treatment planning. The present study aims to evaluate and compare gender differences for Carey's arch length, Arch form, Arch alignment with various facial growth patterns. Pretreatment lateral cephalograms and dental study models of 180 subjects (18-25 years) were selected and categorized into horizontal, vertical and average growth pattern which was defined by Jarabak's ratio. ANOVA test revealed statistically highly significant ($P<0.001$) differences within growth pattern for Carey's arch length, but on comparing between gender - it was significantly more in females vertical grower ($P\leq0.003$) and highly significant in males average grower ($P<0.001$) but non-significant difference in horizontal grower. However, non-significant difference was found for arch alignment (crowding / spacing) and arch shape (square,u,v) within growth pattern. These findings may be of great help in orthodontic applications along with forensic science.

Index Terms **- Facial growth pattern, Arch length, Arch forms.**

I. INTRODUCTION

Facial morphology has been believed to be the outcome of each person's genotypic and its phenotypic expression. Three basic types of facial morphology exist: Average, Horizontal and Vertical. According to Ricketts et al (1982)1, hypodivergent subjects (brachyfacial) are characterized by wider arch dimensions, and hyperdivergent subjects (dolichofacial) by narrow arch dimensions. The two paramounts of vertical facial dysplasia were also explained as short-(euryprosopic) or long-face (leptoprosopic) syndrome by Opdebeeck and Bell (1978)1. The maxillary and mandibular dental arches can be considered as kind of ribbons, adapted to altering jaw relationships to maintain normal association between the arches for dentofacial esthetic and function.

In daily clinical practice, with increased use of preformed arch wires routinely by many orthodontists regardless of the facial type and gender of the patients to correct transverse dimensions of the dental arches, so increased knowledge of a link between facial proportion and dental arch length, shape can be of immense help to orthodontists. Hence, there is a need to correlate different arch forms and Carey's arch length with acceptable esthetic facial framework of male and female3.

Hence in orthodontics, for proper diagnosis and treatment planning, the configuration of vertical with transverse facial proportions along with maxillary and mandibular dental arch form of an individual should have to be taken into consideration and it is important factor that aids in the treatment selection, biomechanical consideration and stability of treatment outcome.

Therefore, the purpose of present study is to investigate whether Carey's arch length and arch form, arch alignment correlate to various vertical facial patterns as determined by Jarabak's ratio in untreated male and female adults.

II. MATERIAL AND METHODS

The present study was carried out in the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College & Hospital, Ahmedabad. It was approved by the ethical committee. 180 subjects (18-25 years) from Government Dental College were selected for this study.

Selection Criteria:

Inclusion criteria:

- Subjects with CVMI stage 6 (Hassel and Farman method).
- No previous history of orthodontic treatment, surgery, trauma.
- No apparent facial asymmetry.
- All permanent teeth should be present except third molars.
- According to Jarabak's ratio, skeletal pattern in vertical relation was defined as average, vertical and horizontal growth pattern.

Exclusion criteria:

- Missing or supernumerary teeth.
- TMJ disorder, muscle dysfunction and presence of unilateral chewing.
- Any other systematic disturbances.
- Any other oral destructive habits, habit of bruxism & presence of attrition.
- Presence of any developmental dental anamolies, dental caries and restorations.

CEPHALOMETRIC STUDY

For all the subjects, standardized lateral cephalometric radiographs were taken in centric occlusion with lips in relaxed and the Frankfort plane oriented horizontally according to Natural Head Position (NHP) to classify samples. The digital cephalometric tracing was done using FACAD orthodontic tracing software version 3.11.

Cephalometric reference points:

- **N – Nasion**: the most anterior point on the frontonasal suture in the median plane.
- **S - Sella** : Midpoint of sella , hypophysis cerebri (sella turcica)
- **Go- Gonion:** the lowest, posterior and lateral point of angle of mandible.
- **Me- Menton**: most inferior point in the symphysis.

CEPHALOMETRIC PARAMETERS

Anterior facial height(N-Me)
Posterior facial height(S-Gn)
Jarabak's ratio = Posterior facial height (S-Go) x 100 Anterior facial height(N-Me)

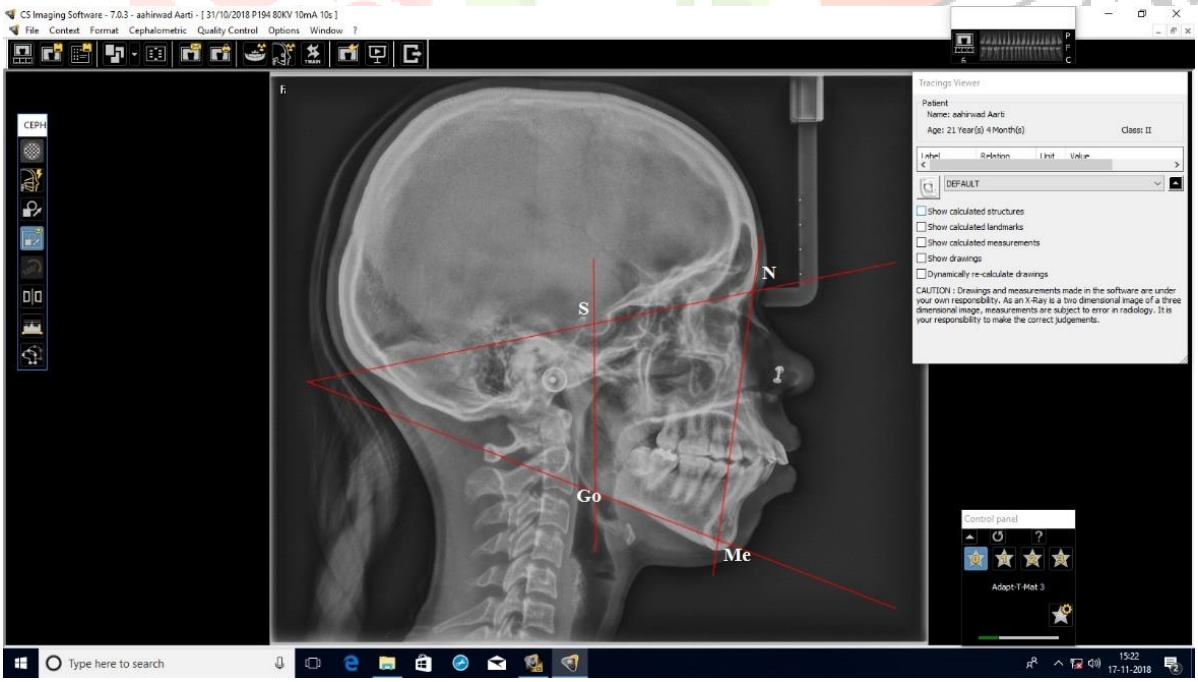


Figure showing cephalometric parameters of Jarabak's ratio

Sample size:

Equal numbers of male (n=30) and female (n=30) subjects were selected to make a total sample size to classify the sample in various vertical facial morphology. The subjects were classified into three groups:

GROUP		Jarabak's Ratio	TOTAL	SUBGROUPS
A	Average	**62-65%**	**60**	**A1= 30 males**
				A2=30 females
B	Horizontal	**>65%**	**60**	**B1=30 males**
				B2=30 females
C	Vertical	**<62%**	**60**	**C1=30 males**
				C2=30 females

MODEL STUDY:

Same 180 subjects were chosen for model study purpose. Upper and lower alginate impressions were taken and dental casts were prepared. Dental cast measurements were recorded manually by using a Digital Vernier calipers (HI-MEZAR) 150X0.01mm/6X0.0005in accurate to 0.01mm and brass wire.

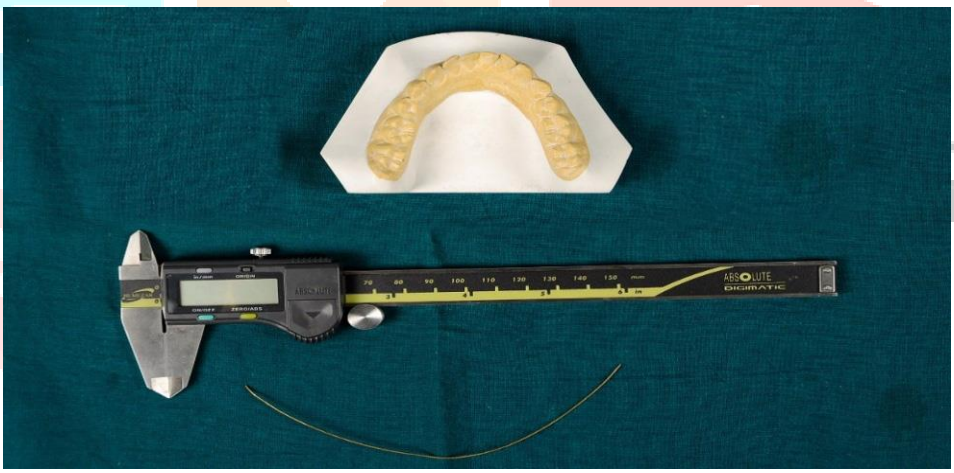
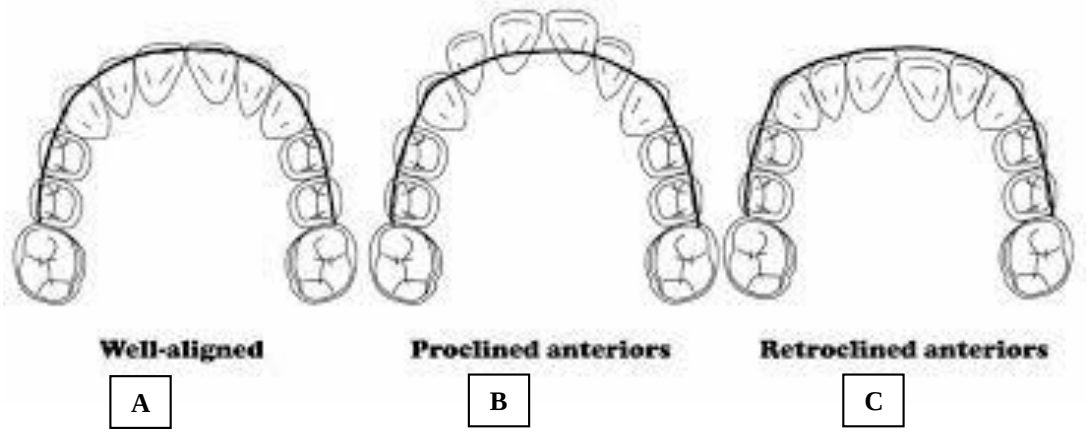


Figure shows armamentarium of model study

Measurement of Carey's Arch Length

- Measured using a 0.012 inch soft round brass wire.
- The wire was adapted to the model on mandibular arch so that one end engages first permanent lower molar near the mesio buccal line angle, then wire passed over the buccal cusps of the premolars, and over the normal cuspal position of the cuspid, then over the anterior teeth at ridge center and finally followed the same course on the opposite side, ending in mesio buccal line angle of lower first permanent molar of the other side.
- The wire was marked and cut at this point and straightened and the length was recorded using digital vernier caliper. Things to be taken into consideration when:

➢ Well aligned anterior teeth, the wire was passed over the incisal edges of the anterior teeth.(A)
➢ Proclined anteriors, the brass wire was passed along the cingulum of the anterior teeth.(B)
➢ Retroclined anteriors, the brass wire was passed labial to the anterior teeth.(C)



Determination of Arch Shape

Based on examination of study models they were classified as either U, V Or Square shape by considering center point of mesio-distal width of each clinical crown which was marked from 2nd molar of right side to 2nd molar of left side, then this points were joined as an imaginary line and arch shape was determined.

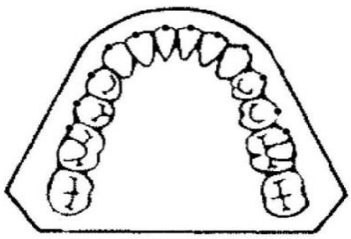
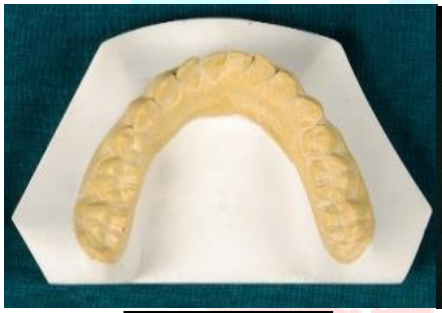


Figure shows method to identify arch form in mandible



U Arch shape

V Arch shape

Square Arch shape

Assessment of Arch Alignment

Arch alignment was assessed as crowding (irregularly arranged teeth with slip of contacts) or spacing (lack of contact with adjacent teeth) and categorized as whether present or absent.

Data was collected and statistical analysis was done.

III. RESULTS AND DISCUSSION

The statistical methods that were performed in the present study - Mean, Standard Deviation, Standard Error, P value, one way ANOVA, CHI-SQUARE TEST and Post hoc tuckey test(LSD).

Table 1: Descriptive statistics of various Cephalometric parameters

	Group	N	Minimum	Maximum	Mean	Std. Deviation	F value	P value
Jarabak's Ratio	Horizontal	60	64.61	74.76	70.8930	2.65101	716.948	<0.001**
	Average	60	60.80	65.50	63.3367	1.20225		
	Vertical	60	52.80	60.80	56.0600	2.31042		
Anterior Facial height (N-Me)	Horizontal	60	96	119	104.08	6.914	26.675	<0.001**
	Average	60	96	112	104.34	4.536		
	Vertical	60	106	118	110.00	2.617		
Posterior facial height (S-Go)	Horizontal	60	65.0	86.0	72.833	5.1787	228.759	<0.001**
	Average	60	60.0	72.0	65.550	2.8785		
	Vertical	60	53.0	66.0	58.067	2.7914		

Table 1 shows Mean of Anterior facial height which was more in Vertical then Horizontal and Average grower, whereas increased Posterior facial height in horizontal then Average and Vertical grower which was highly significant (P<0.001).

Table 2: Intergender comparison of various cephalometric parameters

Group	Parameter	Gender	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	P value
Horizontal	Nme	Male	30	109.40	5.531	1.010	10.633	<0.001**
		Female	30	98.77	2.861	.522		
	Sgo	Male	30	76.500	4.4237	.8077	7.3333	<0.001**
		Female	30	69.167	2.6792	.4892		
		Female	30	24.867	2.2087	.4032		
Average	Nme	Male	30	106.03	3.499	.639	3.447	0.003*
		Female	29	102.59	4.866	.904		
	Sgo	Male	30	65.700	3.3130	.6049	.3000	0.690 NS
		Female	30	65.400	2.4155	.4410		
Vertical	Nme	Male	30	110.00	2.639	.482	0.000	1 NS
		Female	30	110.00	2.639	.482		
	Sgo	Male	30	58.067	2.8154	.5140	0.0000	1 NS
		Female	30	58.067	2.8154	.5140		

NS- not significant (p>0.05), *-Significant (p<0.05),**-Highly significant (p<0.001)

Table 2 depicts that Male Horizontal grower had increased anterior and posterior facial height which was highly significant (P<0.001), whereas in average grower anterior facial height was significantly (P≤0.03) more in males then females. No gender differences were found for anterior and posterior facial height in Vertical grower.

Ibrahim et al(2018)[11] also stated that Saudi males had greater anterior and posterior facial height.

Table 3: Inter-group pairwise comparison of cephalometric parameters

Parameter	Comparison Between		Mean Difference (I-J)	Std. Error	Sig.
Nme	Horizontal	Average	-.256	.919	0.958 NS
		Vertical	-5.917*	.915	<0.001**
	Average	Vertical	-5.661*	.919	<0.001**
Sgo	Horizontal	Average	7.2833*	.6904	<0.001**
		Vertical	14.7667*	.6904	<0.001**
	Average	Vertical	7.4833*	.6904	<0.001**
JR	Horizontal	Average	7.55633*	.39174	<0.001**
		Vertical	14.83300*	.39174	<0.001**
	Average	Vertical	7.27667*	.39174	<0.001**

NS- Not significant (p>0.05), **-Highly significant (p<0.001)

On Comparing mean difference for anterior facial height, which was non-significant between Horizontal and Average grower whereas posterior facial height was highly significant (P<0.001) in all growth pattern (Table 3).

Table 4: Comparison of careys' arch length in various growth patterns

Parameter	N	Horizontal		Average		Vertical		F value	P value
		Mean	SD	Mean	SD	Mean	SD		
Arch Length	60	68.66	2.98	64.87	2.50	61.64	3.23	86.946	<0.001**

Table 4 shows Increased mean of Carey's arch length in Horizontal than average and vertical grower respectively which was highly significant (P<0.001).

Table 5: Intergender comparison of Carey's arch length in various growth patterns

Group	Gender	N	Mean	Std. deviation	Std. error mean	mean difference	P- value
horizontal	Male	30	68.2377	3.36352	.61409	-.85433	0.271 NS
	Female	30	69.0920	2.53516	.46286		
average	Male	30	66.33	1.93829	.35388	2.92533	<0.001**
	Female	30	63.41	2.12970	.38883		
vertical	Male	30	60.46	1.90385	.34759	-2.37800	0.003*
	Female	30	62.83	3.82445	.69825		

Table 5 shows non-significant gender difference for Carey's arch length in Horizontal grower, whereas increased value of Carey's arch length in male average grower which was highly significant (P<0.001) but in vertical grower females had statistically more significant value than males (P≤0.003).

Table 6: Individual pair wise comparisons of Carey's arch length

Parameter	Comparison Between	Mean Difference		Std. Error	Sig.
Arch length	Horizontal	Average	3.79583*	.53298	<0.001**
		Vertical	7.02050*	.53298	<0.001**
	Average	Vertical	3.22467*	.53298	<0.001**

Table 6 shows mean difference of Carey's Arch length between Horizontal, Vertical and Average grower which was statistically highly significant (P<0.001).

Table 7: Comparison of arch alignment in mandibular arch with various growth pattern

Crowding	**Horizontal**		**Average**		Vertical	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
absent	26	43.3	27	45.0	28	46.7
present	34	56.7	33	55.0	32	53.3
Total	60	100.0	60	100.0	60	100.0
Chi sq	0.135			P value	0.935 NS	
Spacing						
absent	34	56.7	33	55.0	32	53.3
present	26	43.3	27	45.0	28	46.7
Total	60	100.0	60	100.0	60	100.0
Chi sq	0.135			P value	0.935 NS	

Table 7 shows presence of crowding in various growth patterns which was more in horizontal than average and vertical grower, but was non-significant. However, spacing was present in vertical followed by average and horizontal grower which was also non-significant.

Mimoza et al (2015)[9] stated that there was non-significant difference for arch length by Lavelle and Foster in crowded and non-crowded subjects but arch length was greater in non-crowded

Table 8: Comparison of Mandibular Arch shape in various growth pattern

Arch Shape	**Horizontal**		**Average**		Vertical	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Square	7	11.7	8	13.3	8	13.3
U shape	38	63.3	39	65.0	36	60.0
V shape	15	25.0	13	21.7	16	26.7
Total	60	100.0	60	100.0	60	100.0
Chi sq	0.529			P value	0.971 NS	

Table 8 shows comparison of mandibular arch shape (Square, U and V shaped) for horizontal, average and vertical grower which was non-significant. U shaped was maximum in average followed by horizontal and vertical grower, V shaped in vertical followed by horizontal and average grower and square shape arch was maximum in vertical followed by average and horizontal grower.

All growth pattern showed more number of subjects with U shaped arch followed by V shape and least was square shaped arches.

-**Mohammed Nahidh et al (2017)**[2] stated that there was no significant association between the facial and dental arch forms.

-**R. Ferro et al (2017)**[10] observed that a similar ovoid and tapered tendency was found, while the square form was the rarest.

- **Cristina Grippaudo et al (2013)**[8] stated changes in upper arch shape with intercanine diameter, proportionately smaller in patients with high angles and larger in low-angle and the genetic component could be partly related to vertical growth patterns and also to functional , muscular and local environmental factors.

-Several factors such as gender dimorphism, ethnic and racial differences, sample selection or size and age of subjects could be responsible for dental arch width variation by **Islam MM and Hussain in 2012**[7]

-Multiple epigenetic and environmental factors could be responsible for disparity in arch form by **Nabila Anwar and Mubassar Fida in 2010**[5]

In the present study, Carey's arch length was measured manually and it varies with inclination of anterior teeth so there are all the chances of getting human error within some negligible range. In our study Jarabak's ratio was only taken to assesse vertical facial pattern so further study can also be conducted with other growth parameters and sagittal discrepancy indicator along with more sample size to find out ethnic, racial and gender variation among targeted population.

An individual's facial pattern along with arch length, arch form and alignment can never be ignored in the field of orthodontics and may be considered as one of the key determinants for treatment option and approach because dentoskeletal factors influences the anchorage requirement, growth estimation of maxillofacial structures and goal of orthodontic treatment.

IV. CONCLUSION

Sexual dimorphism was observed in horizontal and average but not in vertical grower, males had increased anterior facial height in horizontal and average grower and also posterior facial height in horizontal grower.

No gender difference was found for Carey's arch length in horizontal grower, whereas highly significant more value in male Average grower, but significant in female vertical grower.

U, V and Square shape Arch form was non-significant and presence of Crowding and Spacing was also non-significant in all growth pattern by Jarabak's ratio.

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