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TANAKA - JOHNSTON MIXED DENTITION ANALYSIS FOR INDIAN POPULATION.

Dr. Sharma Rati Vedprakash[1], Dr. V. Subhash[2], Dr. Saurabh Rastogi[3], Dr. Piyush Sharma[4]

[1]MDS scholar, Department of Orthodontics And Dentofacial orthopedics, Dental College Azamghar, Veer Bahadur Singh Purvanchal University, Jaunpur, Uttar Pradesh.

[2]Professor and H.O.D, Department of Orthodontics And Dentofacial orthopedics, Dental College Azamghar, Veer Bahadur Singh Purvanchal University, Jaunpur, Uttar Pradesh.

[3]Reader, Department of Orthodontics And Dentofacial orthopedics, Dental College Azamghar, Veer Bahadur Singh Purvanchal University, Jaunpur, Uttar Pradesh.

[4]Lecturer, Department of Orthodontics And Dentofacial orthopedics, Dental College Azamghar, Veer Bahadur Singh Purvanchal University, Jaunpur, Uttar Pradesh.

ABSTRACT:

In diagnostic procedures, the critical area in mixed dentition research is finding sufficient room for permanent teeth erupting. Various analytical methods are available regarding mixed dentition; initially Tanaka and Johnston (TJ) space analysis was performed on a North European descent population. It is trust worthiness among various ethnic and racial groups to be predicted. In this analysis, the summation of MM (Maxillary & Mandibular) canine as well as premolars MWs associated with the sum of widths of 4 permanent mandibular incisors as well as the 1st permanent mandibular molar. Also, equations from linear regression were determined for estimating the number of permanent and premolar MWs. And finally, TJ analysis was evaluated with both the genders of Indian population. For study, two hundred Indian population subjects (100 of each sex) age group between 16-25 years are selected randomly, and research model was prepared to measure the MWs of permanent lower canines, incisors as well as premolars teeth. Both MM canine-premolar widths were also analyzed by using the TJ system. Data was used to estimate MM canine and premolar MWs via descriptive statistical analysis, correlation, Student's t-test as well as regression analysis. Comparison was made of estimated and measured widths of both MM canines to premolars teeth. Thus, its findings showed that the estimated widths of MM canines to premolars teeth were overestimated as compared to their measured widths. New equations of linear regression were calculated by applying Y = a+b(X) formula, where "a" and "b" are constants, Y is expected canine premolar distance, and X is lower incisal-first molar distance. Equations of linear regression, for both genders (male and

female) were extracted separately. Overall, conclusion is that the original TJ process for Indian population is overestimated. Prediction tables as well as for linear regression new separate equations were created for both genders, which the clinician could use more conveniently.

KEYWORDS: Mixed Dentition, Tanaka and Johnston, Indian Population, Maxillary and Mandibular.

I. INTRODUCTION:

In contemporary orthodontics, early diagnosis is gradually normal due to increased oral health understanding and clinical care availability. Before orthodontic treatment, a mixed dentition analysis is imperative[1]. A common condition requiring early therapy includes crowding. This is due to a mismatch among available space in dental arch space available as well as entire dental material[2]. Every disparity in tooth size and arch length must be considered to prepare effective future management and this can be achieved with a mixed dentition study.

Mixed dentition study helps to determine whether the treatment plan involves space repair, space rehabilitation, eruption instruction, serial extraction or patient evaluation[3]. Space analysis in mixed dentition is sub-categories into following steps:-

(1) Regression equations[4, 5]

(2) Radiographs [4, 6, 7, 8]

(3) A mixture of the two methods [9,10,11]

Of all mixed-dentition analysis, Moyers probability charts and TJ equations [12] are the most commonly used regression equations. Tanaka and Johnston[5] proposed a simpler chair side evaluation method. Initial TJ study on a population of North European descent was conducted[13]. But assessment in Indian population also applies.

Variability in tooth sizes have been seen based on race of a specific nation as well as community [14], and various racial groups[15]. Racial dimorphism in tooth size also prevails[16]. Very few literature studies were cited using Indian population TJ equations[17, 18]. As a result, the following are the study results goals: -

1. To compute the value of the MWs of MM canine as well as premolars depending upon widths of 4 permanent mandibular incisors and mandibular 1st permanent molar.

2. To find linear regression equations which can forecast the summation of MWs of permanent canines and premolars.

3. To analyze the applicability of TJ analysis in both genders subject in the Indian population.

Data collected was measured by dial caliper, and then further analyzed by using TJ analysis, for age group between 16-25years of Indian population.

II. MATERIAL AND METHOD:

1. THE SAMPLE:

The analysis was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Dental College Azamghar. The research sample consisted of 100 male and 100 female Indian populations between 16-25 years.

2. CRITERIA FOR INCLUSION:

- Completely erupted permanent teeth in all arches up to second molars.
- Individuals with age group between 16-25 years to prevent any differences based on proximal wear.

3. CRITERIA FOR EXCLUSION:

- Teeth with severe hypoplasia or hypocalcification
- Proximal caries, and proximal wear repair or fractures
- Past record of orthodontic therapy
- Dental defects
- Cross bite relationship, reverse speech, depletion, or other abnormality

4. STUDY MODEL PREPARATION:

For impression MM arches of selected Indian population, alginate impressions were made using the authorized manufacturer basic material mixing procedures. Impressions rinsed in hot water and disinfected with 2% glutaraldehyde. After someday, impressions were poured using the normal mixing technique with dental stones materials. Dental casts weren't waxed or soaped.

5. TEETH CALCULATION:

Every tooth maximum mesiodistal crown width was determined, according to Thimmegowda and co-workers[19]. This approach is highly effective to calculate mesiodistal crown widths[20]. The MWs of mandibular incisors, canines as well as premolars of MM are measured using dial calliper (Mitutoyo Corporation, Japan, Tokyo), calibrated to 0.01mm. Standard approach is used to verify reliability of measurement as by Flores-Mir and co-workers[21].Single investigator conducts measurements by carefully labelling the MW(maximum) on teeth, and then re-measuring some casts by chosen randomly.

6. MEASURABILITY INTRA OBSERVER:

The test reliability coefficients for randomly selected seventy two (36 males and 36 females) casts were determined and the value of r was 0.98, confirming reliability. Estimated width of canine teeth, 1st and 2nd pre-molar teeth, and whole value of MW was measured by calculating the lower incisors along with first permanent molar using of Tanaka-Johnston formula for the lower and upper arch respectively [22]:

X = Y/2 + 10.5

X = Y/2 + 11

where,

Y = Number of Incisors

X = On one side of the arch estimated number of canine as well as premolars

For the left and right sides, accurate widths of both upper as well as lower canines along with premolars were determined just on left and right sides, and then apply their mean value so as

to reduce real combination width of both canines as well as premolars. However, mean disparity between the left and right sides don't vary significantly among teeth in both lower and upper arches (LUA).

For statistical analysis, Social Sciences Software Package (SPSS) version 20.0 is used. Descriptive statistical analysis, correlation, student t-test and regression were analyzed along with male and female probability tables. Study the level of significance as $p<0.05$.

III. RESULTS:

Examination through statistics indicated that the estimated width of lower canine premolar was higher than their actual width/measurements by 1.78 mm, and statistically ($p<0.001$) significant too [Table-1]. Similarly, for upper canine-premolar their estimated width was higher than their actual width/measurements by 0.69 mm, and statistically ($p<0.001$) significant too [Table-1]. The current research findings showed that the TJ analysis showed significantly high unerupted canine premolar estimated width for LUA. Thus, equation of linear regression for specific population was required to derive. So, in this study new equations were derived for predicting canines and premolars MWs segment though analysis by linear regression, and equations were expressed by:

Y=a+b(X)

where,

Y = Canines-premolars MWs to be estimated for LUA

a and b = Derived constants

X = Combined MW of all lower incisors and first molar

Therefore, the parameters regarding prediction equations of LUA were derived separately.

In MM arch and mandibular arch, segment of canine-premolar showed 0.472 and 0.511 respectively correlation coefficient, while standard estimated error was 0.519 and 0.457 in maxilla and mandible respectively [Table-2]. A major variances were detected using the Student t-test ($p=0.017$) between the genders for LCpM width where males showed higher width as compared to females. But for combined MW related to all lower incisors and the first permanent molar showed marginally significant differences ($p=0.061$) with males have females have more width than males. However, in Table-3 for UCpM, genders have no ($p=0.43$) dissimilarities significantly. Furthermore, linear regression analysis was done based on gender to get a separate predicted equation for both genders to both LUA. The values of correlation coefficients both "a" and "b" for linear regression equations along with estimated standard errors are mention in [Table-4]. New linear regression equations as per our calculations for Indian population of both genders are depicted in [Table-5].A model for prediction was suggested to estimate width of canine-premolar for both sexes in the LUA separately by considering combined MW of all lower incisors and first permanent molar [Table-6].

IV. DISCUSSION:

This study was conducted to determine canines-premolar MW along with verifying the application of the TJ method to Indian population. This study having cross-sectional analysis while examining the co-relation between lower incisors and later segments for tooth size.

Many equations of linear regression analysis showed that as these are the teeth that erupted first at the time of an early mixed-dentition, the MW among all 4 permanent mandibular incisors as well as the mandibular 1st permanent molar are regarded as the greatest determinants predicting unerupted canines-premolars. The MW among all 4 permanent mandibular incisors along with the very first permanent molar were found to be strongly linked to the MW of erupted canines premolars in this study. Space analysis system of TJ is most widely used in mixed dentition in different populations[23, 24, 25, 26, 27, 28, 29]. Research study Tanaka and Johnston greatly overvalued the true MWs of the Indian population MM canines and premolars so new regression equations were derived. Except this, there were major variances discovered between measured and projected canines-premolar widths.

For mixed dentition, the capacity to anticipate mesiodistal measurements of unerupted permanent canines-premolars seems important for medication as well as diagnostics preparation. MW of tooth is mainly determined by gene while environmental factors having minor effect on general variation in dentition[30].Sexual dimorphism was evident in male and female mesiodistal density for central incisors, canines, as well as premolars. The findings of this research demonstrated a substantial variation in the width of LCpM between male and female, and showed that males have slightly more widths as compare to females. A marginally significance also observed for Incisors combined mesiodistal distance, and it also showed slightly more widths among males as compare to females. However, there is no substantial difference in UCpM width across the genders. Several studies showed significant sexual dimorphism in UcpM width[31, 32, 33]. Therefore, division of subjects by gender was required for mixed dentition study.

Several studies emphasized significant racial and ethnic variations in tooth size[32,34,35].In the recent study a significant variability is seen between mean real permanent values of canine and premolar MWs, as well as those MWs values resultant through TJ method. The variability in results may be due to variation sample ethnic origins as suggested by Asiry and co-worker[36] during his study on Saudi Arab population for applicability of TJ method. Similar results have been identified for different population in Indian studies[17, 19, 37,38,39, 40,41]. Racial disparities are very significant variables in tooth size prediction methods, according to previous study and current research. However, there is indeed a void in the literature addressing the derivation of equations of linear regression particularly with local population, so this research aims to bridge that space by developing the equations of linear regression for the Indian population. To estimate unerupted permanent canines and premolar total MWs for every population group, TJ method cannot have correct applicability. So in study, new regression equations were also calculated after deriving constant values “a” and “b”. New sample regression equations are mentioned in [Table-5]. Regression equations vary among ethnic and racial groups, therefore new prediction equation of linear regression for Indian population of each gender is presented separately in [Table-6]. Different local population showed variability among their erupting canines and premolar MWs, so different equations required for different population. Thus, current research also developed new equations of linear regression for Indian population. Distinct population has many regression equations which are listed in [Table-7].

V. CONCLUSION:

The method was used for Northern European ancestry but was not reliable for an Indian population. Thus, new regression equations were derived for Indian population to predict the space needed to align unerupted canines as well as premolars in both genders which helps in minimizing the time in case of management and planning clinician.

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TABLES OF PAPER – 1 TO 7

Table 1: Show the descriptive statistical analysis for combined MWs of both upper and lower canine and premolar, to compare the width of the student paired t-test was used to compare, evaluate and observe (in mm) for canine premolars.

	Sample size	**Minimum**	**Maximum**	**Mean**	**St Dev**	**Mean difference (in mm)**	**p-value**
Lower incisors sum and 1st permanent molar	200	19.56	30.1	24.05	1.89		
Measure UCpM	200	20.10	24.6	22.87	0.87	0.69	p<0.001*
Estimated UCpM	200	20.08	25.5	23.24	0.89		
Measure LCpM	200	18.85	24.7	22.79	0.85	1.78	p<0.001*
Estimated LCpM	200	20.01	25.3	23.12	0.89		

*Statistically significant; Abbreviation - UCpM: Upper Canine Premolar width and LCpM: Lower Canine Premolar width.

Table 2: Variables of forecasting equations for both arch -Maxillary and Mandibular

Segment Canine premolar	**Correlation Coefficient**	**Coefficients of regression**		**Standard error estimate (in mm)**
		a	**b**	
Maxillary	0.472	16.57	0.28	0.519

Mandibular	0.511	15.97	0.25	0.457

Table 3: Student t-test to compare mean study variables between men and women

Parameters	Gender	Sample size	Mean	Standard Deviation	SEM	Mean Difference	T value	P-value
LIM	Males	100	24.37	2.18	0.18	0.42	1.932	0.061
	Females	100	23.95	1.44	0.11			
UCpM	Males	100	22.90	0.88	0.07	0.05	0.769	0.43
	Females	100	22.85	0.91	0.06			
LCpM	Males	100	22.84	0.59	0.03	0.15	2.295	0.017*
	Females	100	22.69	0.65	0.05			

* Statistically significant; Abbreviation: LIM – Combined MW of lower incisors and first permanent molar. UCpM-Upper canine premolars; LCpM-Lower canines' premolars.

Table no. 4: Width of canine and premolar estimations in the Indian population age group between 16 to 25 years – Predicted Values

Variable	X	Gender	Const a	p-value a	Const b	p-value b	r2	SEE	r
UCpM	LIM	Males	17.914	p<0.001*	0.311	p<0.001*	0.256	0.775	0.506
UCpM	LIM	Females	16.628	p<0.001*	0.365	p<0.001*	0.179	0.831	0.421
LCpM	LIM	Males	18.212	p<0.001*	0.276	p<0.001*	0.356	0.518	0.597
LCpM	LIM	Females	14.449	p<0.001*	0.432	p<0.001*	0.248	0.829	0.499

In India, analysis through linear regression is applied in order to get regression equations mostly in manner of Y=a+b (x), that are applied medically for tooth size forecasting. Every combination of both the mandibular incisors as well as 1st permanent molar, the standard error of the forecasted values of MM was determined as well. UCpM-Upper canine premolars; LCpM-Lower canines' premolars.

Table 5: Derivation of new canine as well as premolar width regression equations for both genders of the Indian population age group between 16 to 25 years

Arch	Gender	Equation	R	p-value
Maxillary	Males	Y=17.914+0.311*(X)	0.506	p<0.001*
	Females	Y=16.628+0.365*(X)	0.421	p<0.001*
Mandibular	Males	Y=18.212+0.276*(X)	0.597	p<0.001*
	Females	Y=14.449+0.432*(X)	0.499	p<0.001*

Table 6: Forecasted MWs for both genders of canines and premolars for Indian population age group between 16-25 years.

LIM (in mm)	Male		Female	
	Upper	Lower	Upper	Lower
19.56	20.95	19.78	20.59	19.64

19.57	20.99	19.95	20.68	19.72
19.58	21.45	20.95	20.98	19.78
19.75	21.56	20.99	21.04	19.98
20.02	21.79	21.09	21.35	20.56
21	21.86	21.25	21.44	21.45
21.14	21.91	21.44	21.59	21.45
21.28	21.99	21.56	21.67	21.45
21.39	22.11	21.78	21.74	21.64
21.89	22.15	21.92	21.85	21.86
21.95	22.17	21.98	21.91	21.89
21.99	22.20	22.13	21.98	21.95
22.04	22.21	22.42	22.01	22.13
22.59	22.46	22.61	22.05	22.21
22.76	22.54	22.62	22.09	22.23
23.12	22.61	22.63	22.17	22.25
23.46	22.67	22.65	22.19	22.26
23.97	22.78	22.81	22.26	22.35
22.99	22.78	22.82	22.54	22.46
24.13	22.79	22.85	22.72	22.68
24.75	22.80	22.86	22.75	22.76
24.86	22.81	22.86	22.76	22.78
24.95	22.81	22.88	22.76	22.79
25.05	22.82	22.91	22.77	22.81
25.15	22.84	22.92	22.78	22.81
25.64	22.91	22.94	22.80	22.82
26.01	22.94	22.96	22.81	22.83
26.8	23.01	22.99	22.87	22.85
27.26	23.07	23.05	22.93	22.97
27.99	23.09	23.07	23.05	23.00
28.13	23.11	23.09	23.09	23.05
28.38	23.14	23.11	23.13	23.14
29.15	23.17	23.19	23.19	23.20
29.73	23.17	23.20	23.19	23.22
29.82	23.18	23.21	23.20	23.24
30.08	23.19	23.26	23.25	23.27

Abbreviation: LIM – Combined MW of lower incisors and first permanent molar.

Table 7: Derivation of several regression equations for diverse population

Population	**Regression equation**	
	Male	**Female**
Saudi [Asiry et al., 2014]	A:Y=10.3+0.49 (X)	A:Y=11.7+0.39(X)
	B:Y=9.7+0.49(X)	B:Y=11.3+0.39(X)
Thai [Jaroontham and Godfrey, 2000]	A:Y=13.36+0.41(X)	A:Y=11.16+0.49(X)
	B:Y=11.92+0.43(X)	B:Y=9.49+0.53(X)
Western UP [Srivastava et al., 2016]	A:Y=9.6+0.40(X)	A:Y=9.4+0.37(X)
	B:Y=9.3+0.42(X)	B:Y=8.9+0.46(X)
Belgaum [Durgekar and Naik,	A:Y=10.52+0.48(X)	A:Y=11.73+0.41(X)

2009]	B: Y=9.46+0.50(X)	B:Y=11.67+0.39(X)
Nalgonda [Manjula et al., 2013]	A:Y=11.0+0.50(X)	A:Y=11.1+0.495(X)
	B:Y=10.4+0.50(X)	B:Y=10.4+0.502(X)
Bangalore [Thimmegowda et al., 2017]	A: Y=16.90+0.21(X)	A:Y=15.63+0.26(X)
	B: Y=17.20+0.17(X)	B:Y=13.43+0.33(X)
Indian [Current Study]	A:Y=17.914+0.311(X)	A:Y=16.628+0.365(X)
	B:Y=18.212+0.276(X)	B:Y=14.449+0.432*(X)

Abbreviation: A=maxillary and B= mandibular