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The mesiodistal Crown Width Measurements and Bolton Analysis in Down's Syndrome with Class I Normal Occlusion. (A Comparative study)

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Abstract

Information concerning tooth size in human population is important for clinician, since it may explore the role of genes and their possible effect on the dental characters, as the tooth size and morphology served as genetic markers.

Aims of study: to compare the mesiodistal crown width of patient with Down's syndrome to that of control norms and explore the possible irregularities between the left and right side for both jaws in different sexes and to totaled and computed the Bolton ratios for the different groups.

Material and methods: This study was conducted on 58 patients with Down's syndrome aged (13-21) years; the mesiodistal crown dimension was estimated for the upper and lower permanent teeth and compared with those of control group matching the age and the Angle classification (Class 1)

Results showed a non significant sexual dimorphism in both arches and showed a similar size order distribution to the control group .but the mean width value of the Down's patient significantly smaller than that of norms with some exceptions, these factors make the Bolton value to increase to a great extent than the original one

Keyword: Crown width, Bolton ratio, Down's syndrome

Introduction

Mesiodistal tooth width has an anthropological significance because it provides valuable information on human evolution with its technological and dietary changes[1]. Differences in tooth size have been associated with different ethnic backgrounds and malocclusions [2-4]. Many factors such as genetic, growth of the bone, eruption and inclination of the teeth, external influences and function would affect the size and shape of the teeth and dental arches [5].

Mongolism is one of the congenital anomalies associated with sub normal mentality. There are two main forms of Down's syndrome [6,7]:

1-Typical trisomy 21 with 47 chromosomes which compromised about 95%.
2-Familial Down's syndrome appear to have only 46 chromosomes although extra chromosomal material of no. 21 is translocated to another chromosome and it compromised 4%
3-The rest characterized by having Down's syndrome with mosaicism.

The incidence[8] of this syndrome at various maternal ages is as follows:

- 15-29 years - 1 case in 1500livebirths
- 30-34 years - 1 case in 800 live births
- 35-39 years - 1 case in 270 live births

- 40-44 years - 1 case in 100 live births
- Older than 45 years - 1 case in 50 live births

Down's syndrome characterized by having variety of anomalies and functional disorders .It showed cardinal signs of the syndrome characterized by a flat face , small slanting eyes , low-set small ear, open mouth and the most concerning anomalies are those of craniofacial type with other varied effects. A lot of authors reported different types of oral disorders in Down's syndrome patients, they clamed that Those patients exhibited Small mouth (relatively) with protrusion of the tongue (macroglossia) and difficulty in eating and speaking, scrotal tongue, hypoplasia of the maxilla, delayed tooth eruption, juvenile periodontitis, and cleft lip or palate (rare)[9,10] . However few of them focused on malocclusion and its orthodontic consideration. Crowding, spacing, arch perimeters, hypodontia …etc. is considered as important variables to explore the possible genetic role of this syndrome from its characters[11]. Ghaib [12] found that the maxillary arch dimensions of patient with Down's syndrome were smaller and narrower than those of normal population.. The cephalometric analysis revealed length deficiency of the anterior cranial base with an anteroposterior deficiency of maxillary arch ,regular but hypoplastic growth, and a diminished anteroposterior growth of the mandible[13] .

The extent of mentally deficiency in individuals with down's syndrome has often been exaggerated in the literature and this may have caused the orthodontist to shy away from treating these patients[14].Because of medical advancement and improved educational system as well as recognition of oral characteristics, individuals with Down's syndrome present with an improved and promising health and can be incorporated to any orthodontic practice.

Treatment objectives in patient with Down's syndrome [10]

- Alignment of maxillary arch
- Obtain Class I profile depending on acceptable aesthetic features
- Alignment of the lower arch
- Stabilize the buccal segment by keeping good molar relation despite the angle classification
- Obtain good overjet overbite relation
- Keep Class I canine classification
- Dealing with the residual spacing

Correct maxillary and mandibular mesiodistal tooth size relationship is important to the achievement of proper occlusal inter digitations and so oral function[15]**.** Bolton[16] computed the specific ratios of the mesiodistal widths that must exist between maxillary and mandibular teeth. The mesiodistal widths of the 12 maxillary teeth (first molar to first molar) were totaled and compared with the sum derived by the same procedure carried out on the 12 mandibular teeth. The ratio derived between the two is the percentage relationship of mandibular arch length to maxillary arch length.

The same procedure was carried out to analyze the six anterior teeth (from canine to canine).

Materials and method

patients attended the center of health care for Down's syndrome (Hibbat-Allah) in Baghdad City were clinically examined .Among 150 patients with Down's syndrome , all Iraqi nationality,, only (58) patients were selected consisted of (27 males ,31 females) with an age range (13-21) .

Selection criteria:

- All patient have class I normal occlusion (according to Angle) with full complement of permanent dentition except the third molars.
- There is no marked skeletal asymmetry
- There is no severe crowding or spacing (the allowed spacing or crowding is less than 2 mm)
- There is no gross restoration build up ,class II restorations or crowns that affect the mesiodistal width of the dentition.
- No transverse discrepancies such as crossbite or scissors bite.

The control group consisted of 60 patients (30 male, 30 female) matching the age and the selected criteria.

All the patients were clinically examined with mouth mirror , then the impression were taken with perforated trays using alginate hydrocolloid impression material (Dentaurum) .Dental casts then fabricated with dental stone using the vibrator.

The measurements are carried out on the upper and lower casts for all teeth, except the third molars. The measurements made directly on dental casts, from the largest mesiodistal distance i.e. from the anatomical mesial contact area to the anatomical distal contact area, using the sharp end vernier caliper, with the sharp end beaks being parallel to the long axis of the crown .The caliper inserted from the buccal (labial) surface with the instrument held at right angle to the long axis of the crown[17], permitting reader to nearest 0.1mm**,** and recorded on data sheets.

Bolton tooth size ratios were computed for each individual as described by Bolton[16]

$$\text{Overall ratio} = \frac{\text{Sum mandibular 6-6}}{\text{Sum maxillary 6-6}} * 100$$

$$\text{Anterior ratio} = \frac{\text{Sum mandibular 3-3}}{\text{Sum maxillary 3-3}} * 100$$

Statistical analysis was carried out using SPSS program version 12 in which the descriptive statistic (mean and standard deviation), and inferential statistic by student's t test were carried on.

Results

In the maxillary dental arch, the mean mesiodistal crown dimension of the central incisors is larger than that of laterals, and the first premolars are larger than the second premolars. While in the lower arch, the lateral incisors are greater than the centrals, while the second premolars have larger mean value than the first unlike the control group where the first premolars are the larger one, as shown in table (1)

The results of this study demonstrate a non significant difference between the left and right antimeres of the mean value of the mesiodistal width of all the teeth in Down's syndrome group for both sexes. However in control group, the mean width of the first molars showed significant difference at $p < 0.05$. As in table 2

Patients with Down's syndrome reveal a non significant difference between the mesiobistal crown dimension in both sexes and the male show larger mean value of the central incisors, canines and second molars in upper arch and lateral incisors, canines and second molars in the lower arch. Table 1

Table (3) shows that the mesiodistal with of the control group are significantly larger than the study group except in lower centrals and second premolars and second molars.

Detailed sexual dimorphism of the dentition with both groups is obviously seen in table (4,5)

Finally, table (6) exhibits the value of Bolton ratios (the overall and the anterior) concerning both group, which are 93.3% and 81,9% successively.

Discussion

The greatest value to know a syndrome is to allow much better prediction of the nature of future development of the individual with that syndrome.

Mongolism is one of the interesting disorders in which the patients exhibit multisystemic anomalies

The collected data from this study revealed a slight increase in the slandered deviation of some teeth, especially the canine and molars, in Down's patients, while in control group the upper central incisors and molars. This probably due to the small size of the sample and the individual tooth variation .This tooth variability is explained according the field concept i.e. the farthest from the pole of the field, the most variable the tooth size[18]. However, the order of dental size distribution come in accordance with the results of many studies [17,19,20].

In general , there is no significant difference on the either sides whether in male or female , this explained that the gene responsible for the dental trait is not affected by any sort of mutation and the same genetic and/or environmental factors governing the teeth equally on both sides, as commented by [17,19-23].

Although the result demonstrate non significant difference between both gender in Down's syndrome, the female exhibit greater mesiodistal means values of some teeth like the upper laterals, lower centrals ,upper and lower premolars and first molar in both arches. This sexual dimorphism may be due to small sample size and uneven gender distribution ,this results come in accordance with some authors [17,24,25] as they commented that the sexual dimorphism increase relatively to their position from the canine which is considered as the center of field of the sexual dimorphism. On the other hand males in control group show a non significant larger mean value than females with some exceptions in that females have larger mesiodistal means of lower centrals, even though males exhibit significant difference at level $p<0.05$ in mean value of upper second molars and the first molars in both arches, a result supported by many studies [25-27] .

The mesiodistal crown width of upper teeth show a significant difference at different levels ($p<0.05$,$p<0.005$) with the larger mean value in control group in both gender, in contrast the females in Down's syndrome individuals demonstrated a non significant difference in the mean value of the lateral incisors and first molars. While the lower arch showed almost the same results, but with some exceptions in that the mesiodistal width of the central incisors, second premolars and second molars were not significantly differed from the mean value of the control group.

Several authors clamed that variation in tooth size influenced by genetic and environmental factors, the inherent variation may be represented by ethnic, sexual and chromosomal–link gene [24.26], some of the environmental factors affect the dentition during the prenatal period but seem to have little influence on dental variation. Others like Loudstrom[28] commented that tooth size is determined to a large extent by the genetic factors rather than environmental [19].

Even though various degree of admixture with in a population could result in anew genetic pole which may aggravate the anomalies when other factors synergizes that. Hence, tooth size variation is best explained by a polygenic model of inheritance [29],

Several studies[24,25,30,31] summarized the significant role that heredity plays in the determination of tooth size. It has been shown that (1) tooth size and morphology is under rigid genetic control and (2) the genes that determine whether or not the tooth size and morphologic traits will be expressed are independent.

These hypothesis brought to think that the tooth size trait in Down's syndrome individuals is of genetic influence, a fact supported the symmetrical tooth size in both sides and the overall small size dentition, with some environmental modulations i.e. the functional anomalies occur in those patients brought an environmental impactions, especially hormonal dysfunction, on the genetic trait which subsequently alter the phenotypic characteristics. this is true when these factors appear early in life.

As a result, Bolton value showed greater value than the original one .Surprisingly, both control and Down's syndrome patients demonstrate this feature with almost the same degree, this reflects the relatively small size lower teeth rather than the upper and this is obviously clear in the anterior region. These come in close results by [20]. The small size teeth occupy relatively small jaws in those patients resulted in harmonious relation ship between tooth size and jaw size as clamed by [12].

Conclusions

1-The dentition in patients with Down's syndrome are significantly small in relation to that of corresponding norms..

2-The sexual dimorphism in those patients simulates that of norms.

3-There is no aberrant tooth antimeric difference.

4-The dental size trait here is of genetic influence that modulated by environmental factors enhanced by hormonal dysfunction.

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Table(1):Descriptive statistics show the mesiodistal crown dimension of the upper and lower teeth for both gender in Down's and control group(mm)

Variable		Mongolic teeth						Control					
		mean (Male)	S.D	mean (Female)	S.D	t test P value	Sig.	mean (Male)	S.D	mean (Female)	S.D	t test p value	Sig.
Centtral incisor	upper	8.45	0.55	8.31	0.37	0.421	NS	9.00	0.50	8.90	0.60	0.59	NS
	lower	5.56	0.38	5.84	0.55	0.234	NS	5.60	0.40	5.70	0.30	0.182	NS
Lateral incisor	upper	6.26	0.48	6.38	0.44	0.577	NS	7.00	0.49	6.90	0.30	0.746	NS
	lower	5.86	0.45	5.79	0.56	0.548	NS	6.30	0.27	6.30	0.27	1.000	NS
Canine	upper	7.24	0.62	6.98	0.68	0.524	NS	8.10	0.40	8.00	0.40	0.808	NS
	lower	6.20	0.52	6.09	0.46	0.800	NS	7.20	0.26	6.90	0.29	0.066	NS
First premolar	upper	6.61	0.46	6.84	0.17	0.235	NS	7.50	0.20	7.50	0.20	1.000	NS
	lower	6.49	0.55	6.72	0.34	0.283	NS	7.50	0.20	7.20	0.24	0.062	NS
Second premolar	upper	6.43	0.58	6.87	0.32	0.139	NS	7.20	0.30	7.20	0.40	0.983	NS
	lower	6.70	0.40	6.93	0.22	0.166	NS	7.40	0.34	7.20	0.30	0.432	NS
First molar	upper	10.23	0.69	10.44	0.27	0.401	NS	11.20	0.60	10.50	0.47	0.004	S
	lower	10.33	0.55	10.52	0.91	0.509	NS	11.50	0.20	11.20	0.30	0.042	S
Second molar	upper	8.40	0.97	8.00	0.57	0.606	NS	9.74	0.51	8.85	0.65	0.009	S
	lower	8.90	0.61	8.40	0.57	0.895	NS	8.70	0.35	8.61	0.51	0.694	NS

(P<0.05)، N.S= non significant (p>0.05) , S=Significant

Table(2):: Comparison between the mesiodistal crown width of the left and right sides in both groups(mm)

Variable		Mongolic teeth								control							
		Male				Female				Male				Female			
		Right	Left	p value	Sig.	Right	Left	p value	Sig.	Right	Left	p value	Sig.	Right	Left	p value	Sig.
Centtral incisor	upper	8.3	8.6	0.492	NS	8.5	8.1	0.103	NS	9.0	9.1	0.874	NS	8.9	8.8	0.729	NS
	lower	5.6	5.5	0.602	NS	5.8	5.8	0.734	NS	6.0	6.2	0.546	NS	5.7	6.0	0.252	NS
Lateral incisor	upper	6.4	6.1	0.388	NS	6.3	6.0	0.255	NS	7.0	7.3	0.387	NS	6.9	6.8	0.815	NS
	lower	5.9	5.8	0.848	NS	5.7	5.9	0.441	NS	6.0	5.9	0.625	NS	6.3	6.2	0.769	NS
Canine	upper	7.0	7.2	0.621	NS	7.2	7.3	0.537	NS	8.0	7.8	0.324	NS	8.0	8.0	0.962	NS
	lower	6.2	6.3	0.608	NS	6.1	6.4	0.260	NS	7.2	7.0	0.487	NS	6.9	6.8	0.682	NS
First premolar	upper	6.8	6.9	0.961	NS	6.6	6.5	0.681	NS	8.0	7.9	0.928	NS	7.5	7.4	0.901	NS
	lower	6.5	6.6	0.675	NS	6.7	6.7	0.784	NS	8.0	8.0	1.000	NS	7.2	7.2	1.000	NS
Second premolar	upper	6.8	6.9	0.930	NS	6.4	6.4	1.000	NS	7.0	6.9	0.637	NS	7.2	7.1	0.762	NS
	lower	6.7	6.8	0.712	NS	7.0	6.9	0.562	NS	7.0	7.0	1.000	NS	7.0	6.8	0.703	NS
First molar	upper	10.5	10.3	0.866	NS	10.2	10.3	0.516	NS	11.0	11.0	1.000	NS	10.5	10.3	0.491	NS
	lower	10.3	10.5	0.546	NS	10.6	10.4	0.671	NS	12.0	11.5	0.006	HS	11.2	10.8	0.009	HS
Second molar	upper	8.2	8.3	0.630	NS	8.4	8.2	0.752	NS	9.7	9.6	0.427	NS	8.9	9.0	0.945	NS
	lower	8.9	9.1	0.481	NS	8.9	8.9	0.966	NS	8.7	8.8	0.619	NS	8.6	9.1	0.043	NS

N.S= non significant (p>0.05) , S=Significant، (P<0.05)

Table(3): Comparison between the mesiodistal crown width means of upper and lower dentition of the Down's and control group.(mm)

Variable	Upper						Lower					
	Mongolic	S.D	Control	S.D	t test	Sig.	Mongolic	S.D	Control	S.D	t test	Sig.
Centtral incisor	8.39	0.46	8.95	0.35	0.000	HS	5.70	0.48	5.65	0.44	0.858	NS
Lateral incisor	6.31	0.45	6.95	0.58	0.001	HS	5.83	0.49	6.15	0.39	0.022	S
Canine	7.11	0.63	8.00	0.37	0.000	HS	6.15	0.48	7.1	0.32	0.000	HS
First premolar	6.70	0.38	7.55	0.52	0.000	HS	6.59	0.47	7.33	0.56	0.000	HS
Second premolar	6.55	0.55	7.19	0.37	0.003	S	6.78	0.36	7.27	0.45	0.302	NS
First molar	10.33	0.53	10.85	0.38	0.015	S	10.42	0.71	11.35	0.58	0.000	HS
Second molar	8.27	0.85	9.29	0.73	0.001	HS	8.65	0.60	8.66	0.42	0.935	NS

N.S= non significant (p>0.05) , S=Significant (P<0.05)

Table(4): Comparison between the mesiodistal crown width means of the upper teeth in Down's and control groups.(both gender)in mm.

Variable	Male						Female					
	Mongolic	S.D	Control	S.D	P value	Sig.	Mongolic	S.D	Control	S.D	P value	Sig.
Centtral incisor	8.45	0.55	9.00	0.50	0.032	S	8.31	0.37	8.90	0.60	0.003	HS
Lateral incisor	6.26	0.48	7.00	0.69	0.014	S	6.38	0.44	6.90	0.30	0.054	NS
Canine	7.24	0.62	8.10	0.40	0.002	HS	6.98	0.68	8.00	0.40	0.001	HS
First premolar	6.61	0.46	7.50	0.20	0.000	HS	6.84	0.17	7.50	0.20	0.005	HS
Second premolar	6.43	0.58	7.20	0.30	0.042	S	6.87	0.32	7.20	0.40	0.015	S
First molar	10.23	0.69	11.20	0.60	0.012	S	10.44	0.27	10.50	0.47	0.686	NS
Second molar	8.40	0.97	9.74	0.51	0.004	HS	8.00	0.57	8.85	0.65	0.035	S

N.S= non significant (p>0.05) , S=Significant (P<0.05)

Table(5): Comparison between the mesiodistal crown width means of the lower teeth in Downs and control groups.(Both gender)in mm.

Variable	Male						Female					
	Mongolic	S.D	Control	S.D	P value	Sig.	Mongolic	S.D	Control	S.D	P value	Sig.
Centtral incisor	5.56	0.38	5.60	0.40	0.744	NS	5.84	0.55	5.70	0.30	0.579	NS
Lateral incisor	5.86	0.45	6.30	0.27	0.032	S	5.79	0.56	6.30	0.27	0.009	S
Canine	6.20	0.52	7.20	0.26	0.000	HS	6.09	0.46	6.90	0.29	0.001	HS
First premolar	6.49	0.55	7.50	0.20	0.000	HS	6.72	0.34	7.20	0.24	0.022	S
Second premolar	6.70	0.40	7.40	0.34	0.256	NS	6.93	0.22	7.20	0.30	0.853	NS
First molar	10.33	0.55	11.50	0.20	0.000	HS	10.52	0.91	11.20	0.30	0.005	S
Second molar	8.90	0.61	8.70	0.35	0.376	NS	8.40	0.57	8.61	0.51	0.261	NS

N.S= non significant (p>0.05) , S=Significant (P<0.05)

		Sum of teeth3-3	Sum of teeth 6-6	Bolton ratio 3-3		Bolton ratio 6-6	
				Mean	S.D	Mean	S.D
Mongolism	upper teeth	43.43	89.71	81.9	0.04	93.3	0.08
	lower teeth	35.53	83.34				

Control	**upper teeth**	44.98	93.13	79.7	0.03	90.6	o.o3
	lower teeth	38.08	89.58				

Table (6) :Bolton ratios, the anterior and overall ratios, in Downs and control groups.(In percentage)