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RESEARCH ARTICLE

Tooth Size in Patients with Mild, Moderate and Severe Hypodontia and a Control Group

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Abstract:

Objectives:

To compare tooth size between subjects with mild, moderate and severe hypodontia and a control group.

Material and Methods:

The study comprised 120 patients with hypodontia divided into three groups of 40 mild (≤ 2 teeth congenitally missing), 40 moderate (3-5 teeth congenitally missing) and 40 severe (≥ 6 teeth congenitally missing) hypodontia; and 40 age and sex matched controls. Tooth size was recorded by measuring the mesiodistal and buccolingual dimensions of all fully erupted teeth on study models using digital callipers and compared between all hypodontia and control groups using Two-way ANOVA and Post Hoc Tests of subgroup comparison.

Results:

Two-way ANOVA revealed patients with hypodontia had significantly smaller mesiodistal and buccolingual tooth dimensions compared with controls ($p < 0.05$). Furthermore patients with more severe hypodontia demonstrated significantly smaller tooth dimensions than those in the mild and moderate hypodontia subgroups ($p < 0.05$). The most affected tooth in terms of tooth size reduction was the maxillary lateral incisor and the least affected tooth was the mandibular first molar.

Conclusion:

Patients with hypodontia have smaller tooth dimensions than control. Tooth size appears to be affected by the degree of hypodontia, with severe hypodontia having a greater effect on tooth size reduction. The findings of this study may contribute to understanding the aetiology of hypodontia and aid the multidisciplinary management of this complex condition.

Keywords: Congenitally, Dimension, Hypodontia, Missing, Size, Tooth.

INTRODUCTION

Hypodontia is defined as the congenital absence of one or more of the primary or permanent teeth. It is one of the most common dental anomalies [1 - 6] with an overall prevalence of 6.4% [7]. Different classifications for hypodontia have been reported by various authors according to their severity [8 - 20]. But the most common one includes: mild with 1 to 2 teeth congenitally missing, moderate with 3 to 5 teeth congenitally missing and severe with 6 teeth or more congenitally missing [17, 21]. The latter type is sometimes called oligodontia [5, 7, 22]. Generally, hypodontia occurs more often in females than in males [8, 16, 18, 23]. The exact aetiology of hypodontia is not yet well known, but both genetic and environmental factors have been shown to play significant roles [24 - 41].

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Hypodontia can occur as an isolated dental anomaly or as part of a syndrome. It has been reported that non-syndromic hypodontia occurs in association with other dental anomalies such as delayed eruption of the remaining permanent teeth, reduction in crown and root tooth dimensions, retained primary teeth, ectopic permanent maxillary canines, transposition and rotation of teeth, taurodontism and peg-shaped maxillary lateral incisors and reduced alveolar bone [1, 5, 13 - 15, 37, 38, 42 - 48]. The association between hypodontia and a reduction in tooth size of the remaining dentition (microdontia) has been reported by some studies [15, 17, 25, 37, 38, 43, 46, 49], but others were unable to find such an association [50 - 52]. Furthermore, none of the previous studies have investigated the impact of the severity of hypodontia on tooth size changes of the remaining teeth using the most common classification method of hypodontia and the most common tooth size dimensions namely mesiodistal (MD) and buccolingual (BL) measurements. Therefore, it was important to carry out the present study due to the importance of gaining a detailed knowledge about tooth size of the remaining dentition of patients with hypodontia to aid the diagnosis and treatment planning of this complex dental anomaly which often requires a multidisciplinary approach. Moreover, this knowledge will help to better understand the aetiology of hypodontia.

MATERIAL AND METHODS

A sample size calculation was carried out to determine the number of subjects required in each comparison group of interest. It was found that 20 subjects will be required in each subgroup to detect a clinically significant difference of 0.9 mm with 0.05 alpha and 0.2 beta. The study sample consisted of 120 patients with hypodontia divided into three groups of 40 mild (≤ 2 teeth congenitally missing excluding third molars), 40 moderate (3-5 teeth congenitally missing excluding third molars) and 40 severe (≥ 6 teeth congenitally missing excluding third molars) hypodontia; and 40 age and sex matched controls, but with a full complement of the permanent dentition. Each subgroup contained 20 males and 20 females. All hypodontia patients were selected from the Joint Hypodontia Clinic at Aberdeen Dental Hospital, Aberdeen, UK and the control group was selected retrospectively and consecutively from the staff Orthodontic Treatment Waiting List. All subjects were Caucasians, without general medical conditions or syndromes, had no supernumerary teeth and no previous orthodontic treatment. The patient's notes and OPT radiographs were examined to ensure that all patient's details were correct and all the inclusion criteria were met with accuracy including, the congenital absence of teeth for the hypodontia individuals. The age range for the whole sample was 12-18 years and the mean age of the hypodontia group was 13.94 years (standard deviation (SD) 1.8 years) compared with a mean of 14.20 years (SD 2.1 years) for the controls. Study models were constructed for all 160 subjects. The mesiodistal (MD) and buccolingual (BL) measurements were taken from the dental casts of all permanent teeth, excluding the third molars, that were fully erupted, without carious cavities, restorations, excessive tooth wear or severe crowding. The mesiodistal diameter of each tooth was measured with the aid of a digital calliper (Digital Calliper, 0-150 mm, Linear Tools 2001) up to the 2nd decimal digit and as described by Moorrees and Reed [53]. The buccolingual diameter was defined as the maximum length between the buccal and lingual surfaces of the clinical crown of each tooth and perpendicular to the mesiodistal diameter. All measurements were carried out by one trained operator (KK) twice and the mean value of the two measurements was used. Measurement repeatability was assessed using limits of agreement. The mean and standard deviation of the differences were used to construct a range of agreement within which 95% of the differences in measurements would lie. The method error was carried out on six tooth types from both jaws. The teeth were obtained from 20 randomly selected study models of which 10 were hypodontia patients and 10 control subjects. The teeth were measured twice 4 weeks apart for intra-operator repeatability. There was no systematic bias as the paired sample *t*-test of the differences between the double recordings showed none of the differences were statistically significant ($p > 0.05$). With regard to the random error the method showed a high level of repeatability with a maximum value of the repeatability coefficient of 0.39 mm.

Statistical Analysis

Statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois, USA) version 17.0. Distribution of the data was tested using Kolmogorov-Smirnov test which showed a normal distribution ($p > 0.05$) and therefore, parametric tests were used. Comparison between the study and control groups was performed using two-way ANOVA. As the study involved multiple comparisons the subsequent *p* values were corrected by multiplying the *p* values by the number of tests.

RESULTS

Two-way ANOVA revealed no significant interaction between Group and Gender as factor variables and therefore

groups were compared regardless of genders. Gender differences (within groups) indicated that the males showed larger measurements than females although few findings reached statistical significance.

Table 1 shows comparison of the mesiodistal and buccolingual measurements of the maxillary and mandibular teeth of the mild, moderate and severe hypodontia groups with controls and Table 2 shows Post Hoc Tests of the subgroup comparisons of the mesiodistal and buccolingual measurements of the maxillary and mandibular teeth. Table 3 shows percentage reduction in the mesiodistal and buccolingual tooth dimensions of hypodontia patients compared with controls.

Table 1. Comparison of mesiodistal and buccolingual measurements of the maxillary and mandibular teeth according to severity of hypodontia.

Tooth	Measurement	Group I		Group II		Group III		Group IV		P-value
		Mean \pm SD	N	Mean \pm SD	N	Mean \pm SD	N	Mean \pm SD	N	
U1	MD	7.89 \pm 0.53	40	7.20 \pm 0.80	39	6.71 \pm 0.79	40	8.14 \pm 0.67	40	< 0.001
	BL	6.51 \pm 0.70	40	6.20 \pm 0.64	39	5.59 \pm 0.86	40	7.05 \pm 0.37	40	< 0.001
U2	MD	5.32 \pm 1.01	25	4.87 \pm 0.80	24	4.25 \pm 1.14	22	6.28 \pm 0.55	40	< 0.001
	BL	5.46 \pm 0.63	25	5.40 \pm 0.96	24	4.31 \pm 0.78	21	6.12 \pm 0.47	40	< 0.001
U3	MD	6.99 \pm 0.52	40	6.65 \pm 0.66	36	6.25 \pm 0.64	34	7.07 \pm 0.59	40	0.334
	BL	7.23 \pm 0.84	40	6.94 \pm 0.87	36	6.31 \pm 0.66	34	7.90 \pm 0.58	40	< 0.001
U4	MD	5.76 \pm 0.50	40	5.29 \pm 0.73	38	4.96 \pm 0.50	19	6.01 \pm 0.41	40	< 0.001
	BL	8.57 \pm 0.66	40	8.19 \pm 0.73	38	7.32 \pm 0.52	21	9.31 \pm 0.48	40	< 0.001
U5	MD	5.74 \pm 0.54	39	5.39 \pm 0.65	34	5.02 \pm 0.48	22	5.94 \pm 0.60	40	< 0.001
	BL	8.73 \pm 0.64	39	8.39 \pm 0.71	35	8.08 \pm 0.60	22	9.45 \pm 0.37	40	< 0.001
U6	MD	9.64 \pm 0.68	40	9.00 \pm 0.79	39	8.57 \pm 0.89	36	9.78 \pm 0.48	40	< 0.001
	BL	10.90 \pm 0.59	40	10.53 \pm 0.72	39	9.89 \pm 0.49	35	11.02 \pm 0.39	40	< 0.001
L1	MD	5.11 \pm 0.53	39	4.56 \pm 0.76	35	4.25 \pm 0.69	29	5.18 \pm 0.50	40	< 0.001
	BL	5.42 \pm 0.79	39	5.26 \pm 0.60	35	4.64 \pm 0.48	29	6.01 \pm 0.36	40	< 0.001
L2	MD	5.49 \pm 0.56	40	4.83 \pm 0.57	39	4.60 \pm 0.67	33	5.50 \pm 0.39	40	< 0.001
	BL	5.86 \pm 0.74	40	5.57 \pm 0.54	39	5.00 \pm 0.69	34	6.21 \pm 0.34	40	< 0.001
L3	MD	6.16 \pm 0.60	40	5.59 \pm 0.56	40	5.35 \pm 0.47	38	6.45 \pm 0.40	40	< 0.001
	BL	6.73 \pm 0.83	40	6.56 \pm 0.63	40	5.83 \pm 0.68	38	7.38 \pm 0.43	40	< 0.001
L4	MD	6.14 \pm 0.65	40	5.57 \pm 0.80	39	5.40 \pm 0.55	28	6.55 \pm 0.50	40	< 0.001
	BL	7.51 \pm 0.59	40	7.51 \pm 0.61	39	7.03 \pm 0.38	28	8.03 \pm 0.42	40	< 0.001
L5	MD	6.43 \pm 0.61	36	5.80 \pm 0.98	25	5.46 \pm 0.76	9	6.53 \pm 0.57	40	< 0.001
	BL	8.09 \pm 0.58	36	7.77 \pm 0.90	24	7.18 \pm 0.70	9	8.56 \pm 0.33	40	< 0.001
L6	MD	9.87 \pm 0.85	40	9.44 \pm 0.76	39	8.88 \pm 0.74	37	9.94 \pm 0.52	40	< 0.001
	BL	10.26 \pm 0.60	40	10.05 \pm 0.62	40	9.40 \pm 0.58	37	10.30 \pm 0.42	40	< 0.001

U: upper; L: lower; SD: standard deviation; group I: mild hypodontia; group II: moderate hypodontia; group III: severe hypodontia; and group IV: normal controls; MD: mesiodistal; BL: buccolingual.

Table 2. Post Hoc Tests of subgroup comparison of mesiodistal and buccolingual measurements of the maxillary and mandibular teeth.

Tooth	Measurement	Subgroup comparisons					
		I-II	I-III	I-IV	II-III	II-IV	III-IV
U1	MD	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	BL	.024	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
U2	MD	.058	< 0.001	< 0.001	.012	< 0.001	< 0.001
	BL	.747	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
U3	MD	.161	.905	.991	.144	.158	.914
	BL	.073	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
U4	MD	< 0.001	< 0.001	.012	.010	< 0.001	< 0.001
	BL	.006	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
U5	MD	.001	< 0.001	.040	.002	< 0.001	< 0.001
	BL	.016	< 0.001	< 0.001	.049	< 0.001	< 0.001

(Table 2) cont....

Tooth	Measurement	Subgroup comparisons					
		I-II	I-III	I-IV	II-III	II-IV	III-IV
U6	MD	< 0.001	< 0.001	.380	.007	< 0.001	< 0.001
	BL	.002	< 0.001	.276	< 0.001	< 0.001	< 0.001
L1	MD	< 0.001	< 0.001	.541	.020	< 0.001	< 0.001
	BL	.185	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
L2	MD	< 0.001	< 0.001	.938	.055	< 0.001	< 0.001
	BL	.016	< 0.001	.003	< 0.001	< 0.001	< 0.001
L3	MD	< 0.001	< 0.001	.007	.026	< 0.001	< 0.001
	BL	.249	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
L4	MD	< 0.001	< 0.001	.002	.220	< 0.001	< 0.001
	BL	.975	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
L5	MD	< 0.001	< 0.001	.423	.106	< 0.001	< 0.001
	BL	.042	< 0.001	.001	.013	< 0.001	< 0.001
L6	MD	.004	< 0.001	.624	< 0.001	.001	< 0.001
	BL	.087	< 0.001	.700	< 0.001	.037	< 0.001

U: upper; L: lower; group I: mild hypodontia; group II: moderate hypodontia; group III: severe hypodontia; and group IV: normal controls; MD: mesiodistal; BL: buccolingual.

As it can be seen from Tables 1-3 all hypodontia patients had statistically significantly smaller MD and BL tooth dimensions than those in the control except MD of the maxillary canine in all hypodontia groups and the following measurements in the mild hypodontia group: MD and BL of the first molars and MD of the mandibular incisors and mandibular second premolar. In addition, severe hypodontia group had greater reduction in the MD and BL measurements than moderate hypodontia group and this in turn had a greater reduction in the aforementioned measurements than mild hypodontia group when compared with controls. The ranges for percentage reduction in the mesiodistal tooth dimension of the mild, moderate and severe hypodontia groups were 0.72-15.32%, 4.91-22.47% and 10.65-32.35% respectively; and the ranges for percentage reduction in the buccolingual tooth dimension of the mild, moderate and severe hypodontia groups were 0.45-11.85%, 2.48-12.51% and 8.79-29.53% respectively. The most affected tooth in terms of tooth size reduction was found to be the maxillary lateral incisor and the least affected tooth was the mandibular first molar.

Table 3. Percentage reduction in the mesiodistal and buccolingual tooth dimensions of hypodontia patients compared with controls.

Tooth	Mild hypodontia		Moderate hypodontia		Severe hypodontia	
	MD	BL	MD	BL	MD	BL
U1	3.16	7.62	8.74	12.03	14.89	20.72
U2	15.32	11.85	22.47	10.80	32.35	29.53
U3	1.10	8.44	4.91	12.15	10.65	20.04
U4	4.14	7.98	12.02	12.07	17.40	21.42
U5	3.42	7.65	9.19	11.18	15.49	14.52
U6	1.35	1.13	7.95	4.47	12.32	10.29
L1	1.40	9.77	11.87	12.51	17.86	22.71
L2	0.16	5.70	12.25	10.33	16.36	19.45
L3	4.58	8.85	13.33	11.08	17.11	20.95
L4	6.21	6.48	14.96	6.52	17.60	12.43
L5	1.53	5.57	11.21	9.33	16.46	16.13
L6	0.72	0.45	5.10	2.48	10.66	8.79

U: upper; L: lower; MD: mesiodistal; BL: buccolingual.

DISCUSSION

The current study has shown, generally, there were no statistically significant differences in the MD and BL tooth size dimensions between males and females. Similar findings were also reported by many other previous investigations [13, 15, 46, 49, 54] but, Brook *et al.* [38], have shown sexual dimorphism for the canine teeth of the hypodontia groups in comparison with controls with males having a greater tooth size difference. They attributed this difference due to the fact that tooth size of the canine teeth in normal males are greater than that in normal females.

In the current study the congenital absence of teeth was found to be associated with reduction in the MD and BL dimensions of the remaining dentition when patients with hypodontia were compared with controls. This finding agrees with previous studies [13, 15, 25, 38, 46, 49, 54] which have shown an association between hypodontia and microdontia of the remaining dentition. Furthermore, McKeown and her co-workers [46] found the unaffected relatives of hypodontia patients were also affected by microdontia, indicating that hypodontia and microdontia may form parts of a genetically determined condition. But, Wisth *et al.* [50], were unable to find statistically significant differences in the mesiodistal dimension between a hypodontia and a control group. Careful inspection of our findings does show that our findings corresponds fairly well with Wisth's *et al.*, study as the latter authors investigated only the MD dimension of the first molars and central incisors and their study group was predominantly of mild hypodontia with one or two teeth congenitally missing. K uchler *et al.* [51], in their study of clinical records and orthopantomograms from 1198 patients treated at the Federal University of Rio de Janeiro's Continuing Education Clinical Program in Pediatric Dentistry were unable to find a statistically significant difference in tooth size between 56 hypodontia patients and 111 control subjects. The difference between the findings of our study and those of the latter one was due to the fact that the latter study did investigate tooth size of only the maxillary lateral incisors using a clinical observation, rather than odontometric measurements, which is subjective in nature and thus prone to great inaccuracy. Chung *et al.* [52], reported that hypodontia was not associated with changes in tooth size. The difference between this study's finding and the findings in our study may be attributed to the differences between the two studies in term of sampling whereby Chung's *et al.*, sample was a referred orthodontic population, racial differences where Chung's *et al.*, sample was a Korean population and the control used in Chung's *et al.*, study was a historical control obtained from 94 Korean adults with a Class I normal occlusion [55]. Moreover, Chung's *et al.*, investigated only the MD dimension of the remaining dentition in a predominantly mild hypodontia group.

Another finding in the current study was that, as the severity of hypodontia has increased the impact on tooth size reduction of the remaining dentition has also increased. This finding was in accordance with previous investigations [49, 56]. In contrast to these findings Brook *et al.* [38], did find a correlation between the extent of tooth size reduction and the number of congenitally missing teeth in hypodontia patients, but this was not statistically significant when males and females were treated separately. This was most probably due to the smaller sample size when the sexes were considered independently. The moderate hypodontia group in the current study has shown less statistically significant differences of tooth size reduction than that in Gungor and Turkkahraman's study [49] and the opposite holds true for the severe hypodontia group. This may be explained by the different criteria used to classify the mild hypodontia group in the two studies whereby Gungor and Turkkahraman classified the mild hypodontia subjects as those who had 2-5 congenitally missing teeth and thus patients with one congenitally missing tooth were not considered in their mild hypodontia group which may have enhanced the strength of the relationship between tooth size reduction and the number of congenitally missing teeth. With regards to the greater number of statistically significant differences of tooth size reduction in the current study than in Gungor and Turkkahraman's study, this may be attributed to the smaller sample size of the severe hypodontia male subgroup in the latter study which did not allow for some of the differences to reach the statistical significance levels.

One interesting finding in the current study was that more buccolingual dimensions were found to be reduced in the mild hypodontia group than in moderate and severe hypodontia groups when compared with controls. This may suggest a different aetiology for the mild hypodontia group to that for moderate and severe hypodontia groups. Considering that in developing teeth, the mesiodistal dimension is determined before the labiolingual one [17] and that both genetic and environmental factors have been shown to play significant roles in the aetiology of hypodontia [24 - 41] it may be that the environmental factors play a more significant role in the aetiology of mild hypodontia in comparison with moderate and severe hypodontia.

In this study, the greatest tooth size reduction for both MD and BL dimensions was found for the maxillary lateral incisors. Similar finding was reported by previous studies, but for only the MD dimension [38, 49]. The differences between studies for the impact of congenitally missing teeth on reduction of the BL dimension may be attributed to its later completion of development compared with the MD dimension [57] which makes it more prone to the environmental insults and thus a greater variability.

The results of this study will help the multidisciplinary team to manage patients with hypodontia during all stages including the diagnosis, treatment planning and carrying out the treatment. Space analysis as well as Kestling set-ups should carefully be carried out in hypodontia patients to arrive at an optimal treatment plan and decide whether to open, close or redistribute spaces. Intra-arch spaces in hypodontia patients are often greater than the number of congenitally

missing teeth and especially so as the severity of the condition increases due to the extra spaces available from the reduced MD dimensions of the remaining teeth. Moreover, reduction of tooth size in hypodontia patients will make tooth movements more anchorage demanding and accurate placement of the brackets more challenging to the orthodontist. Furthermore, Composite build-ups in hypodontia patients are often required by the restorative dentist to close the excessive spaces, improve tooth form and allow for a good inter-arch relationship.

CONCLUSION

1. Patients with hypodontia had smaller mesiodistal and buccolingual tooth dimensions than control.
2. The more severe the hypodontia the greater reduction in tooth size of the remaining dentition.
3. The most affected tooth in terms of tooth size reduction was the maxillary lateral incisor and the least affected tooth was the mandibular first molar.

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

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