ALVEOLAR BONE HEIGHT IN PATIENTS WITH MILD HYPODONTIA

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Abstract

The purpose of the present study is to investigate whether there are significant differences in the alveolar bone height of a group of individuals with mild hypodontia when compared to a matched in age and gender control group of unaffected individuals.

A retrospective cross-sectional analytical study of panoramic radiographs (OPTs) of patients with mild hypodontia who attended Aberdeen Dental Hospital, UK, aged 11 to 18 years, and of radiographs of patients of a matched in age and gender control group.

Twenty two alveolar bone height measurements were recorded on OPT radiographs of 65 mild hypodontia and 65 age- and gender-matched control individuals with the aid of a digital calliper as described in previous studies.

These variables were compared between the two groups using an Independent samples t-test.

No statistically significant differences were found between a group of patients with mild hypodontia and a matched in age and gender control group ($p>0.05$) for any of the alveolar bone height measurements.

The results of this study support the use of dental implants in the multidisciplinary management of patients with mild hypodontia for the restoration of their congenitally missing teeth.

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Introduction

Hypodontia is a condition characterised by the developmental absence of one or more teeth (excluding third molars). It affects 3.5-6.5% of the general population.[1] It has a wide range of severity, from mild (1 or 2 missing teeth), to moderate (3 to 5 missing teeth) to severe (6 or more missing teeth). The latter form is also commonly called oligodontia.

Hypodontia has been found to affect females more often than males[2-5] and also it appears to have different prevalence in groups of different ethnic background.[5-8] Furthermore hypodontia may be associated with some systemic disorders such as Ectodermal Dysplasia,[9,10] Chondroectodermal Dysplasia, Riegers, Crouzons and Williams syndromes.[11]

Although the causes of congenitally missing teeth is not fully determined as yet, genetic, epigenetic and environmental factors are involved in their multifactorial aetiology.[6, 12-22]

The occurrence and presentations of hypodontia vary, depending on the racial background of a population. It is found that in the Caucasian population the most commonly missing teeth are the lower 2nd premolars and the upper lateral incisors,[6, 23, 24] while in the Asian population the most frequently affected tooth is the mandibular incisor.[6, 24, 25] It is found that it is relatively rare for the upper central incisors, the canines and the 1st molars to be absent.

It is suggested in a meta-analysis on the prevalence of hypodontia that hypodontia is diagnosed more often in the recent years than in the past.[4] However this conclusion can't be considered as firm and definite since the data were limited and the time span not adequate.

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The findings of this meta-analysis are in agreement with the evolutionary theory which suggests reduction with time of the alveolar processes size, of the number of teeth, of the mesio-distal width of teeth and of the skull's facial part.

Hypodontia has been reported to cause difficulties in speech and mastication, as well as to have an impact on the psycho-social well-being of the patient.[23]

The management of hypodontia requires a multidisciplinary approach with the input of various dental subspecialties.[26] Orthodontic treatment is required for the re-distribution of spaces [27] followed most often by the restoration of the missing teeth either by the means of prosthesis [28] or with the aid of dental implants.[29] The restoration of the missing teeth with implants appears to be the gold standard.

Research has shown that individuals with hypodontia present with reduced vertical facial proportions and reduced sagittal jaw relationships.[30-32] Furthermore, there is a suggestion in the literature that hypodontia patients have restricted alveolar bone development.[33]

Knowledge of the levels of the alveolar bone height in individuals with hypodontia would be of great value, since it would enable more effective management of hypodontia patients.

In the literature there are no studies up to date assessing the alveolar bone height in individuals with hypodontia. Therefore this project is undertaken as a pilot study, aiming to assess the height of the alveolar bone in mild hypodontia individuals that would help their management. The null hypothesis is "There is no statistically significant difference in the alveolar bone height between a group of mild hypodontia individuals and a matched in age and gender control group of healthy subjects."

Subjects and Methods

Study design: This is a retrospective cross-sectional analytical study using panoramic radiographs (OPT) of patients with mild hypodontia and age- and gender-matched control groups.

Study sample: A sample size calculation was carried out to determine the number of subjects required in each group. It was found that a minimum of 63 subjects would be required in each group to detect a clinically significant difference of 2mm with 0.05 alpha and 0.2 beta.

The first 65 patients who attended the joint Hypodontia clinic at Aberdeen Dental Hospital, UK and fulfilled the following inclusion criteria were included in the study:

- Caucasian origin.
- One or two permanent teeth congenitally missing (excluding 3rd molars).
- No supernumerary tooth/ teeth.
- Age between 11 to 18 years old at the time of the radiograph.
- Availability of OPT radiograph.
- OPT radiograph of good quality.
- Absence of any syndrome or medical condition that may affect growth and development, such as Ectodermal Dysplasia or Cleft Lip and/or Palate.
- No previous or current orthodontic treatment.

The control group was selected from the staff orthodontic treatment waiting list. The inclusion criteria were the same as in the study group except that all subjects in the control group should have a full complement of the permanent dentition.

Data collection: The patients'notes were examined to ensure that all patient details were correct and all the inclusion criteria were met with accuracy. Date of birth and consequently age and gender of each individual were recorded. For the hypodontia individuals all missing teeth were recorded and confirmed by examination of the OPT radiograph.

Subsequently all OPT radiographs were hand-traced and all the necessary landmarks were highlighted to enable the implementation of the measurements.

Method of assessment of the alveolar bone height: Alveolar bone height was assessed as the linear distance between specific reference points which are anatomical landmarks standardized on OPT radiographic images.[34-36]

For the purpose of this study these landmarks/reference points were determined to be:

- In the maxilla: the lowest point of the alveolar ridge between all existing teeth (up to the mesial aspect of the 1st permanent molars) and its vertical projection to the tangent of the respective area of the most superior border of the maxilla.
- In the mandible: the highest point of the alveolar ridge between all existing teeth (up to

the mesial aspect of the 1st permanent molars) and its vertical projection to the tangent of the respective area of the most inferior border of the mandible.

The linear distance between these points was used for the comparisons between the two groups for the assessment of the alveolar bone in the respective maxillary/mandibular area.

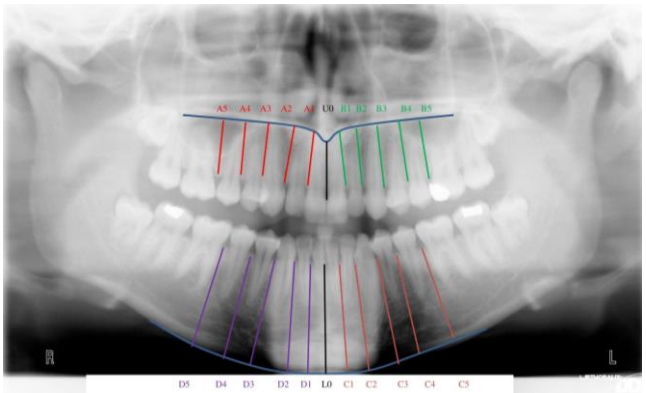
In total there should have been 22 measurements on each OPT tracing (Table 1, Figure 1). In the case of hypodontia subjects where adjacent teeth to the congenitally missing teeth had drifted/ migrated closing the space of the absent teeth, the measurement could not be performed and therefore the total number of measurements on these tracings was less than 22.

Name of measurement	Description of measurement
U0	The alveolar bone height between teeth 11 and 21
A1	The alveolar bone height between teeth 11 and 12
A2	The alveolar bone height between teeth 12 and 13
A3	The alveolar bone height between teeth 13 and 14
A4	The alveolar bone height between teeth 14 and 15
A5	The alveolar bone height between teeth 15 and 16
B1	The alveolar bone height between teeth 21 and 22
B2	The alveolar bone height between teeth 22 and 23
B3	The alveolar bone height between teeth 23 and 24
B4	The alveolar bone height between teeth 24 and 25
B5	The alveolar bone height between teeth 25 and 26
L0	The alveolar bone height between teeth 31 and 41
C1	The alveolar bone height between teeth 31 and 32
C2	The alveolar bone height between teeth 32 and 33
C3	The alveolar bone height between teeth 33 and 34
C4	The alveolar bone height between teeth 34 and 35
C5	The alveolar bone height between teeth 35 and 36
D1	The alveolar bone height between teeth 41 and 42
D2	The alveolar bone height between teeth 42 and 43
D3	The alveolar bone height between teeth 43 and 44
D4	The alveolar bone height between teeth 44 and 45
D5	The alveolar bone height between teeth 45 and 46

16, 15, 14, 13, 12, 11, 21, 22, 23, 24,25, 26, 36, 35, 34, 33, 32, 31, 41, 42, 43, 44, 45, 46 are the permanent teeth using FDI Two-Digit Notation.

Table 1. Name and description of the 22 alveolar bone height measurements used for comparison between the hypodontia and control groups.

All the OPT radiographic images were illuminated with a light box (Kodak Coldlight Illuminator Model 3, Kodak England) and were hand-traced. The measurements were taken in millimetres (mm) with the aid of a digital calliper (Digital Calliper, 0-150 mm, Linear Tools 2001) up to the 2nd decimal digit. All tracings, reference points, landmarks identification and measurements were conducted by a single calibrated operator (KK), which was blinded to the patients' age and gender. It was not feasible to blind the operator to the presence or absence of hypodontia.



U0, A1, A2……D5 see Table 1

Figure 1. Panoramic radiograph with the maxillary and mandibular alveolar bone height measurements.

Random and systematic errors were assessed using Intra-Class Correlation Coefficient (ICCC) and 2 samples t-test. Forty randomly selected radiographs (20 hypodontia and 20 control patients) were traced and all measurements were taken twice 2 weeks apart. The error study for the reproducibility of the measurements showed an acceptable ICCC (0.76). None of the measurements showed significant differences between the 2 groups (P> 0.05) demonstrating no systematic error (bias).

Statistical analysis: Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS 21.0 for Windows, SS Inc, US). All data were found to be normally distributed and therefore independent samples t-test was used to detect significant differences in the mean measurements between the groups.

Results

Table 2 illustrates the distribution of hypodontia and control subjects according to age and gender and Table 3 illustrates the distribution of missing teeth in the hypodontia group.

As it can be seen from table 3 that approximately one third of the subjects had 1 tooth missing and the remaining two thirds had 2 teeth missing. With regards to the type of missing teeth there were 2/3 of the subjects had congenitally missing upper lateral incisors and the remaining 1/3 had congenitally missing lower second premolars.

	Total number of subjects per group	Mean age of Subjects (years)	Number of male subjects	Number of female subjects
Hypodontia	65	14.34y	29	36
Control	65	14.39y	30	35

Table 2. Distribution of group subjects according to age and gender.

Tooth type	U2	L5	Total
Number of subjects-Unilateral	16	3	19
Number of subjects-Bilateral	29	17	46
Total number of missing teeth	74	37	111

U2: upper lateral incisors; L5: lower second premolars

Table 3. Distribution of missing teeth in the hypodontia group.

Measurement	Group				P-Value
	Hypodontia		Control		
	(Mean ± SD)	n	(Mean ± SD)	n	
U0	22.37 ±4.16	65	23.05 ±3.65	65	0.45
A1	22.69 ±3.83	56	23.14 ±3.72	65	0.64
A2	22.51 ±4.23	58	22.37 ±4.07	65	0.98
A3	22.22 ±4.48	63	22.26 ±3.69	65	1.09
A4	21.96 ±4.21	63	22.24 ±3.54	65	0.81
A5	20.73 ±3.90	64	21.74 ±3.44	65	0.24
B1	23.03 ±3.69	55	23.22 ±3.24	65	0.89
B2	22.64 ±3.96	59	22.87 ±3.26	65	0.84
B3	22.25 ±3.92	64	22.57 ±3.24	65	0.73
B4	21.55 ±3.97	64	22.28 ±3.00	65	0.36
B5	20.41 ±3.70	64	21.64 ±2.88	65	0.16
L0	35.79 ±3.58	60	35.81 ±3.99	65	1.11
C1	35.73 ±3.49	65	35.77 ±3.96	65	1.09
C2	35.49 ±3.61	64	35.25 ±4.10	65	0.85
C3	34.68 ±3.69	65	34.47 ±4.10	65	0.89
C4	33.32 ±3.93	64	33.28 ±4.00	65	1.08
C5	31.26 ±4.05	65	31.43 ±3.87	65	0.93
D1	35.60 ±3.46	65	35.78 ±4.13	65	0.91
D2	34.97 ±3.53	64	35.12 ±4.13	65	0.95
D3	34.33 ±3.54	65	34.43 ±3.98	65	1.02
D4	33.05 ±3.65	64	33.03 ±3.95	65	1.11
D5	31.06 ±3.70	65	31.11 ±3.92	65	1.07

U0, A1, A2……D5 see Table 1 above; all measurement units were in mm; SD: standard deviation; n: number of subjects

Table 4. Comparison of Alveolar Bone Height measurements in the hypodontia and control groups.

There were no significant differences in the alveolar bone height measurements between males and females for the hypodontia and control groups ($p > 0.05$) and therefore genders were combined for further analysis. The results of the statistical tests of the differences in alveolar bone height measurements between the hypodontia and control groups are shown in Table 4. There were no significant differences in the alveolar bone height measurements between the hypodontia and control groups.

Discussion

There appears to be a greater number of female patients in both the hypodontia and the control group. This reflects the fact that the uptake of orthodontic treatment is more by females than by males as reported in previous studies [37, 38] and females are more commonly affected by hypodontia than males.[2, 3]

The method established for the measurement of the alveolar bone height on OPT radiographs was based on previous studies. The landmarks used were applied in the past for assessment of the alveolar bone height in various dental patients' categories e.g. edentulous patients or patients planned to receive dental implants. Similar standardised anatomical landmarks were used as reference points by Xie et al.[35] and Salam.[36]

It is suggested in the literature that OPT radiographs present with limited reliability for evaluation and diagnosis purposes, due to magnification and distortion.[39, 40]

On the other hand, other studies have compared the accuracy of the panoramic radiography with that of intraoral radiography for the assessment of the marginal bone tissue. The results of these studies have led to the conclusion that the panoramic radiography was as reliable as conventional intraoral radiography when used to assess the levels of the alveolar bone margin.[41, 42]

In this study the quality of the OPT radiographs was assessed by one operator (KK) and all were found to be of good quality. In addition, it is proven that OPT radiographs taken in hospitals by experienced technicians, demonstrate the lowest levels of distortion.[43] Furthermore, as this is a comparative study and all radiographs were taken by the same operator using the same radiographic machine, the results of the comparison of the same measurements between the two groups should not have been affected.

There do not appear in the literature studies that have assessed the alveolar bone height in individuals with hypodontia on OPT

radiographs. Therefore it is not possible to accurately compare the results of this study, with those of previous ones.

Alveolar bone height was assessed only in one study of hypodontia affected individuals [33] and this was carried out on lateral cephalometric radiographs. The result of this cephalometric study was that hypodontia patients showed reduced alveolar bone height when compared to healthy individuals. The difference in the alveolar bone height between the two groups was found to be clinically and statistically significant, without providing though absolute numerical values. The hypodontia individuals were also found to present with reduced vertical facial proportions. The findings of the present study disagree with those of the former one, since alveolar bone height was not found to be significantly different between the hypodontia and the control groups. This difference may be attributed to the difference in the severity of the hypodontia condition between the 2 studies. While in this study we included only those with mild hypodontia with 1 or 2 teeth congenitally missing, the other study involved a syndromic hypodontia patients with the number of absent teeth (excluding third molars) ranging from 6 to 28 (mean=15.4).

Moreover in the literature it is widely claimed that hypodontia patients present with reduced sagittal jaw relationships and decreased vertical development of the lower face, which are interpreted as a simultaneous reduction in the alveolar bone height.[32, 44-46] The findings of this study did not confirm the above interpretation, since the height of the alveolar ridge appears to show no significant differences between the hypodontia and the control patients.

The fact that the alveolar bone height does not present with clinically significant differences between hypodontia affected individuals and healthy ones, has important clinical implications. The management of hypodontia patients can be facilitated, by implant placement for the restoration of the missing teeth. The same is valid for the placement of implants for anchorage reinforcement during the orthodontic treatment of these patients.

It should be mentioned though that the placement of implants is influenced not only by the height of the alveolar bone. Other factors, such as the width of the alveolar process, the quality of the bone and the distance between the present teeth should also be considered in the decision of implants' placement. Therefore further research is required in this area.

It will be of great value if the alveolar bone height in hypodontia patients with different degrees of severity (mild, moderate and severe) will be investigated to a greater extent. Using larger study and control groups would lead to more definite conclusions. It would also be of benefit if alternative imaging methods would be used , such as cone beam CT imaging, to overcome the limitations of the OPT radiographic images.

Conclusions

- There was no statistically significant difference ($p>0.05$) in the alveolar bone height between a group of patients with mild hypodontia and a matched in age and gender control group.
- The clinical implications of the results are of great importance, since they support the use of dental implants in the management of patients with mild hypodontia.
- Further research is needed for the better validity of the results and to reach more of definite conclusions especially with regards to patients with moderate and severe hypodontia.

Declaration of Interest

The author reports no conflict of interest and the article was not funded or supported by any research grant.

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