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Mild hypodontia is associated with smaller tooth dimensions and cusp numbers than in controls

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ABSTRACT

Objective: The associations seen clinically between variations in tooth number, size and shape reflect the repetitive genetic interactions occurring between the epithelium and mesenchyme during the initiation and morphogenetic stages of the Complex Adaptive System that is dental development. The aim of this study was to investigate the clinical relationship further by comparing multiple crown parameters, including cusp numbers, between patients with mild hypodontia and controls in a Romanian sample.

Design: Digital images of dental casts of the permanent dentition from 28 patients with mild hypodontia and 28 controls were used. Measurements from the vestibular and occlusal surfaces were performed using a 2D image analysis method and cusps, including the Carabelli trait, were counted. Two-way analysis of variance was performed.

Results: The dimensions of the mild hypodontia group had smaller values than the controls, with many measurements being significantly different (significance values varied from $p = 0.049$ to $p = 0.001$). The most affected regions were the upper and lower anterior region in both sexes. Mesio-distal, bucco-lingual and occlusal area and perimeter dimensions were affected. Females from the hypodontia group had significantly less tricuspidated lower premolars when compared with the control group. Carabelli cusps were present in the hypodontia group less frequently, the difference being highly significant ($p = 0.0002$) in women.

Conclusions: The hypodontia patients presented with reduced crown dimensions and shape compared with controls. This is the first published study to demonstrate smaller cusp numbers in patients with hypodontia than in controls. The findings are compatible with a model of dental development as a Complex Adaptive System incorporating associations between tooth number, size and shape.

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1. Introduction

Dental development is a Complex Adaptive System which regulates the initiation and morphogenesis of tooth germs by a series of interactions between genetic, epigenetic and environmental factors that determine tooth number, location, type, size and morphology.[1] Within this system hypodontia and its associated clinical features arise from a multifactorial etiology.[1–5] Dental anomalies affecting tooth morphology may influence the function of the dento-maxillary system. Congenitally missing teeth have not only functional, but also aesthetic and psychological effects on the patient and influence orthodontic treatment. Population studies have shown variation regarding tooth size patterns in different ethnic groups and the different contributions of genetic and environmental factors to these variables.[6] Hypodontia can be syndromical or non-syndromical. Several syndromes with congenital absence of teeth are associated with tooth crown modifications, like: Down syndrome, Kallmann syndrome, ectodermal dysplasias or Rieger syndrome.[7] The present study is therefore focusing on non-syndromical patients. A number of genes are involved in the non-syndromic hypodontia[8] and several studies provided evidence for the etiological model proposed by Brook,[4,8–10] which is now developed further to include shape (Fig. 1).[8] Therefore the study of tooth dimensions and the evaluation of tooth shape in hypodontia subjects contributes to increasing understanding the etiology of this anomaly.[11,12] While a number of studies have been performed to determine tooth dimensions in individuals with hypodontia in different populations,[3,5,6,12] including all degrees of agenesis, none have included cusp number. The aim of this study was to compare multiple crown dimensions and cusp numbers, including Carabelli cusps, in patients with mild hypodontia that is 1 or 2 congenitally absent teeth, against those of controls with a full number of teeth in a Romanian sample.

2. Materials and methods

The study involved 56 subjects: 28 in the mild hypodontia group and 28 in the control group, matched for age and sex. Each group included 16 women and 12 men aged between 13 and 29 years. Inclusion criteria for the hypodontia group were one or two congenitally missing permanent teeth and no evidence reported by the patient or seen on clinical examination of a syndrome known to be associated with hypodontia.[7,13] Third molars were excluded. Diagnosis of agenesis was based on orthopantomograms and anamnestic data in each case. The control group consisted of subjects with evidence of 32 permanent teeth developing. Teeth in eruption, rotated and impacted teeth, teeth presenting with lesions or dental restorations were excluded from both groups. The main reason for exclusion was the presence of dental lesions and restorations. In the control group 20 teeth were excluded, while in the mild hypodontia group 46 teeth were excluded and 53 were missing congenitally. Incisors, canines, premolars and first molars were measured. A total number of 652 teeth were measured in the control group and 576 in the mild hypodontia group (Table 1).

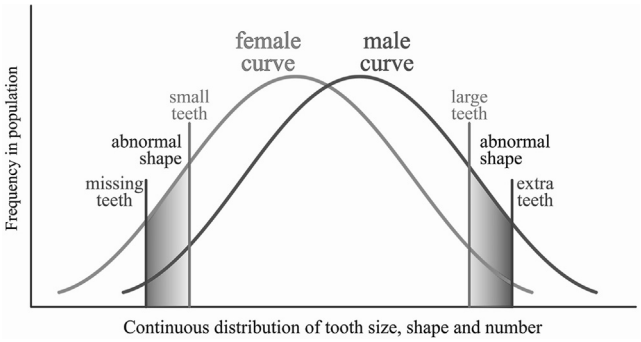

Fig. 1 – A unifying etiological model which accounts for the gender variations in tooth number, size and shape from Brook et al.[8] The greater the variations in tooth number, the more marked the differences in tooth size and shape. (Reproduced with permission from the Australian Dental Journal).

After obtaining ethical approval (reference number: 10/4.02.2013, by the Research Ethics Committee of the University of Medicine and Pharmacy of Tîrgu-Mures) and informed written consent from the subjects, upper and lower dental impressions were taken in alginate and cast in dental stone (Moldano, Heraeus; FujiRock, GC). These study models were mounted on an adjustable stand (standardized lighting and positioning) and an image of the occlusal and vestibular surface of each tooth was captured separately with a digital camera (Nikon D3100, Nikon Corporation, Japan), using a 90 mm Tamron macro lens. The camera was mounted horizontally above the model, on an adjustable stand (Kaiser 5360, Kaiser Fototechnik, Germany) with two halogen bulbs (190 W Tungsram, Hungary) (Fig. 2). Images were transferred with the ViewNX2 (Nikon Corporation, Japan) software and measurements were performed using Image Pro Insight software (Media Cybernetics, USA). A scale was used in each image for calibration. The scale was always placed at the same plane and level as the object and perpendicular to the camera to avoid later calibration errors. After image calibration, mesio-distal (MD), occluso-gingival (OG), bucco-lingual (BL) diameters, vestibular and occlusal perimeters and areas were

Table 1 – Number of teeth measured for each tooth type, sex and group.

Tooth type	Female		Male	
	Control	Case	Control	Case
11_21	32	32	24	24
12_22	32	10	24	11
13_23	30	30	23	22
14_24	30	28	24	24
15_25	30	26	20	20
16_26	32	28	23	22
31_41	32	32	23	22
32_42	32	32	24	24
33_43	32	31	23	24
34_44	32	30	24	20
35_45	32	20	24	20
36_46	28	24	22	20