Dental agenesis and evaluation of body composition through bioelectrical impedance analysis. Observational study on a sample of paediatric subjects



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DOI 10.23804/ejpd.2020.21.02.09

Abstract

Aim The aim of the present study was to evaluate the anthropometric parameters and the body composition through bioelectrical impedance analysis on paediatric subjects with dental agenesis.

Materials and methods The study was conducted on 144 subjects (58.3% females and 41.7% males), aged 7–14 years (average age 10.22±2.53 years). Each patient underwent a dental check-up at the Paediatric Dentistry Unit, University of Rome Tor Vergata (Italy) and a nutritional evaluation, aimed at analysing the anthropometric characteristics and evaluating the indices of body composition through bioelectrical impedance analysis (BIA) at the Human Nutrition Unit, University of Rome Tor Vergata. The sample was divided into three groups: a group with single agenesis (Group 1), a group with multiple agenesis (Group 2) and a control group (Group A). Using the predictive equations, the following values were evaluated: resistance (R), reactance (Xc), phase angle (PHA), body cell mass index (BCMI), body cell mass (BCM), total body water (TBW), intracellular water (ICW), extracellular water (ECW), fat mass (FM), fat free mass (FFM). Statistics: The Excel environment and the SAS System, version 9.3, were used for statistical analysis, providing a descriptive and parametric analysis of the sample. The values of the anthropometric parameters were expressed as mean ± standard deviation. For the statistical analysis of anthropometric parameters and body composition, analysis of variance (1-way ANOVA) was used, which allowed us to find differences and the Student's t-test to compare Groups 1, 2, and A.

Results There is a significant difference in the resistance R value between the case group with single agenesis (Group 1) and the control group (Group A) (R, 710.28±72.46 vs 667.4±104.16, p=0.028), and the phase angle PHA between the case group with multiple agenesis (Group 2) and the control group (Group A) (PHA, 5.18±0.48 vs 5.85±1.05, p=0.028). The BCM% value shows a significant difference between both Group 1 and Group A (BCM%, 50.53 ± 3.29 vs 52.68 ± 4.74, p=0.016) and between Group 2 and Group A (BCM%, 49.25± 2.86 vs 52.68 ± 4.74, p=0.035). The TBW, ICW, ECW, FM, FFM values showed no significant differences between the various groups analysed.

Conclusions Body composition in subjects with dental agenesis presents a higher R, a consequently lower PHA and a lower BCM% compared to the control group. For the first time, the results highlighted the possible relationship between dental agenesis and body composition, measured through BIA.

KEYWORDS Bioelectrical impedance analysis, Body composition, Hypodontia, Tooth agenesis.

Introduction

Hypodontia, tooth agenesis or congenitally missing teeth (CMT) are the developmental absence of tooth buds, and are a frequent dental anomaly [Endo et al., 2006].

At a clinical level CMT present as the absence of one or more deciduous or permanent dental elements, leading to problems at functional, aesthetic and psychological levels [Al-Ani et al., 2017]. The permanent dentition is much more affected than the primary, where hypodontia is reported to be rare [Cobourne, 2007].

Agenesis is classified into hypodontia, oligodontia and anodontia depending on the number of missing teeth. In permanent dentition, hypodontia is an absence of one to six teeth, except for the third molars. Oligodontia occurs when there is an absence of more than six teeth, except the third molars. The term anodontia, instead, describes the lack of all the teeth [Vastardis, 2000].

From an aepidemiological point of view, the prevalence of agenesis varies according to the geographical region, ethnicity and gender; overall, women are affected 1.37 times more than men [Polder et al., 2004]. According to a meta-analysis [Rakhshan and Rakhshan, 2015], the CMT prevalence ranges from 0.15% to 16.18% with a mean of 6.53%±3.33%, and there are significant geographical differences in CMT rates and between ethnicities. Furthermore, there is a statistically significant difference in the prevalence of hypodontia by continent [Khalaf et al., 2014]. Prevalence of hypodontia was highest in Africa (13.4%), followed by Europe (7%), Asia (6.3%) and Australia (6.3%), with a lower prevalence in North America (5.0%) and Latin America and Caribbean (4.4%) [Khalaf et al., 2014].

Tooth agenesis is related to a syndrome or is classified as a non-syndromic form; non-syndromic hypodontia is more common [Nieminen et al., 1995]. Hypodontia is caused by a number of complex interactions between genetic, epigenetic

and environmental factors during the early stages of the dental development process [Brook et al., 2009].

The aim of our study was to evaluate the anthropometric parameters and the body composition through bioimpedentiometry in paediatric subjects suffering from dental agenesis through an observational study.

Materials and methods

The enrolment of 144 healthy patients, aged between 7–14 years, with a mean age of 10.22±2.53 years, was carried out at the Paediatric Dentistry, University of Rome Tor Vergata.

The study was conducted in an ethnically homogeneous population and is representative of the Italian population. Each patient underwent a nutritional examination and dental check-up, after written informed consent of the parents or guardians. The nutritional examination was performed at the Human Nutrition Unit, University of Rome Tor Vergata (Italy) and consisted of anthropometric measurements, BMI calculation and bioimpedentiometry.

Anthropometric measurements

After a 12-hour overnight fast, all subjects underwent an anthropometric evaluation. Subjects were instructed to take off their clothes and shoes before carrying out all the measurements. Body weight (kg) was measured to the nearest 0.1 kg, using a balance scale (Invernizzi, Rome, Italy), height (cm) was measured using a stadiometry to the nearest 0.1 cm (Invernizzi, Rome, Italy) and waist (W) and hip (H) circumferences were measured with a flexible steel metric tape to the nearest 0.5 cm. Waist circumference was measured at the horizontal plane that corresponds with the narrowest point between the iliac crest and the bottom rib. Hip circumference was measured at the largest point when observed on a horizontal plane.

The BMI was calculated using the standard formula: BMI = body weight (kg)/height (m2) [Di Lorenzo et al., 2016].

Bioelectrical Impedance Analysis (BIA)

Bioelectric impedance analysis was performed with a 4-electrode portable single-frequency instrument (BIA 101 Impedance Analyzer; Akern, Florence, Italy), with the aid of Biavector® software for the interpretation of the impedance and reactance data [Di Renzo L et al., 2012].

The Resistance (R), Reactance (Xc), Phase Angle (PHA), Total Body Water (TBW), Intracellular Water (ICW) and Extracellular Water (ECW), Fat Free Mass (FFM), Fat Mass (FM), Body Cell Mass Index (BCMI), Body Cell Mass (BCM) values were calculated.

Dental examination

The dental examination was performed by a trained dentist from the Paediatric Dentistry Unit, University of Rome Tor Vergata, who filled out the medical records and effected an oral health examination.

Medical history was obtained in the interview, including information on asthma, allergies, diabetes, coeliac disease, body growth delay, gastrointestinal diseases, hypothyroidism, systemic diseases, syndromic disorders; these conditions were exclusion criteria for group enrolment.

The dental examination included an intra-oral examination and panoramic radiographic evaluation.

Tooth agenesis was diagnosed when there was no sign of crown calcification on the x-ray and no evidence or history of loss attributable to orthodontic treatment, caries, periodontal disease or trauma.

As premolars show great variability in the initiation of calcification [Wisth et al., 1974; Goya et al., 2008], we considered hypodontia from the age of 7 years to avoid false-positive diagnosis. In general, diagnosis of tooth agenesis in the permanent dentition should be made after the age of 6 years [Goya et al., 2008]. The third molars were excluded in this study.

Subjects classification

The subjects were classified as follows.

Group A (Control Group): Patients without dental agenesis.

Group B (Case Group): Patients with dental agenesis.

The cases were further divided into two groups according to dental agenesis:

Group 1: Patients with single dental agenesis;

Group 2: Patients with multiple dental agenesis (n. 4, 5, 6 dental ageneses).

Statistical analysis

The Excel environment and the SAS System, version 9.3, were used for statistical analysis, providing a descriptive and parametric analysis of the sample. The values of the anthropometric parameters were expressed as mean ± standard deviation.

For the statistical analysis of anthropometric parameters and body composition, analysis of variance (1-way ANOVA) was used, which allowed us to find differences and the Student's t-test to compare Groups 1, 2, and A.

Results

We analysed 144 patients, aged between 7 and 14 years, with a mean age of 10.22 ± 2.53; 84 were females (58.3%) and 60 were males (41.7%).

Group A (Control Group): Patients without dental agenesis, presented 104 subjects with a mean age of 9.19 ± 2.14 years; 57 were females (54.8%) and 47 were males (45.2%). Group B (Case Group): Patients with dental agenesis, presented 40 subjects with a mean age of 10.73 ± 2.72 years; 27 were females (67.5%) and 13 were males (32.5%).

The case group was divided according to the number of dental ageneses, Group 1 (32 patients with single dental agenesis) and Group 2 (8 patients with multiple dental agenesis).

The first analysis of the anthropometric data and of the bioimpedentiometry values, on the whole analysed sample, provided the descriptive results reported in Table 1.

Given the analysis of these results, further evaluation was carried out, dividing Group B into two subgroups, Group 1 and 2, according to the number of diagnosed dental ageneses (Table 2). The average age calculated for the three groups (Group 1, Group 2, Group A) is 11.46 ± 2.57, 10.0 ± 2.87 and 9.19 ± 2.14 respectively; there is a significant difference between the case group with single agenesis (Group 1) and the control group (Group A) ($p<0.001$).

The average BMI found in the Control Group was 19.29± 4.88, in Group 1 18.07 ±3.09, in Group 2 of 17.66± 2.55. There are no significant differences concerning the BMI between the groups.

With regards to the average value of R, in the cases of single agenesis (710.28 ± 72.46) and in cases with multiple ageneses

(687.37± 48.82) there is a higher resistance than in the control group (667.4 ± 104.16) (Table 2, Fig. 1). There is a significant difference in the value of R between the case group with single agenesis (Group 1) and the control group (Group A) (R, 710.28 ± 72.46 vs 667.4 ± 104.16, p=0.028).

The mean value of X appears to be higher in the control group (67.83 ± 12.97) and tends to decrease if the case groups are analysed, respectively Group 1 (67.0 ± 6.83) and Group 2 (62.52 ± 7.92); but these differences are not significant.

The average PHA value is higher in the control group (5.85 ± 1.05) and tends to decrease if the case groups are analysed, respectively Group 1 (5.42 ± 0.59) and Group 2 (5.18 ± 0.48) (Table 2, Fig. 2). There is a significant difference for the PHA value between the case group with multiple agenesis (Group 2) and the control group (Group A) (PHA, 5.18 ± 0.48 vs 5.85 ± 1.05, p=0.028).

On analysing the average BCM% value, results show that in the cases of single agenesis (50.53 ± 3.29) and in the cases with multiple agenesis (49.25± 2.86) there is a BCM% lower than the control group (52.68± 4.74) (Table 2, Fig. 3). There is a significant difference for the BCM% value between both the case group with single agenesis (Group 1) and the control group (Group A) (BCM%, 50.53 ± 3.29 vs 52.68 ± 4.74, p=0.016), and between the case group with multiple agenesis (Group 2) and the control group (Group A) (BCM%, 49.25± 2.86 vs 52.68 ± 4.74, p=0.035).

The BCMI is also lower in the case groups compared to the control group: Group 1 (6.92± 1.14), Group 2 (6.58± 0.75), Group B (7.45±1.80); but these differences are not significant.

Regarding the waist circumference, hip circumference, TBW, ECW, ICW, FM, FFM, no significant differences were found between the various groups studied.

Total group (n=144)	Mean ± SD
Height (m)	1.40±0.14
Weight (Kg)	38.69±14.68
BMI (Kg/m^2)	18.93±4.46
Waist (cm)	64.15±10.54
Hip (cm)	10.54±13.33
R (Ω)	678.04±96.90
Xc (Ω)	67.36±11.66
PHA	5.72±0.97
BCM	14.87±5.60
BCM (%)	52.02±4.50
BCMI	7.29±1.65
TBW	22.36±7.17
TBW (%)	59.32±8.36
ECW	9.48±3.01
ECW (%)	42.76±3.82
ICW	12.88±4.38
ICW (%)	57.24±3.82
Fat Mass (Kg)	10.26±6.58
Fat Mass (%)	24.98±8.81
Lean Mass (Kg)	28.47±9.55
Lean Mass (%)	74.81±9.14

BMI, Body Mass Index; R, Resistance; Xc, Reactance; PHA Phase Angle; BCM, Body Cell Mass; BCMI, Body Cell Mass Index; TBW, Total Body Water; ECW, Extra Cellular Water; ICW, Intra Cellular Water

TABLE 1 Anthropometric and body composition characteristics of the study population

	Group B (n=40)				Group A (n=104)	
	Group 1 (n=32)		Group 2 (n=8)			
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Age (y)	11.46[a]	2.57	10	2.87	9.19	2.14
Height (m)	1.48	0.11	1.43	0.18	1.37	0.13
Weight (Kg)	40.60	10.88	37.52	13.17	38.18	15.82
Waist (cm)	64.25	6.73	61.5	6.8	64.32	11.69
Hip (cm)	80.63	11.96	77.95	13.16	75.60	13.62
BMI	18.07	3.09	17.66	2.55	19.29	4.88
R	710.28[b]	72.46	687.37	48.82	667.4	104.16
X	67	6.83	62.52	7.92	67.83	12.97
PHA	5.42	0.59	5.18[c]	0.48	5.85	1.05
BCM	15.52	4.36	14	4.80	14.74	5.99
BCM %	50.53[d]	3.29	49.25[e]	2.86	52.68	4.74
BCMI	6.92	1.14	6.58	0.75	7.45	1.80
TBW	24.45	5.02	21.82	7.21	21.75	7.64
TBW %	61.31	7.90	58.87	5.91	58.73	8.62
ECW	10.26	2.38	9.85	3.22	9.21	3.13
ECW %	41.93	3.64	45.37	2.82	42.80	3.86
ICW	14.2	2.93	12	4.06	12.54	4.71
ICW %	58.06[f]	3.64	54.62	2.82	57.19	3.86
FM (Kg)	9.98	5.22	9.06	4.19	10.43	7.10
FM (%)	23.81	8.02	23.75	7.36	25.43	9.16
FFM (kg)	30.80	7.23	28.46	9.83	27.75	10.10
FFM (%)	75.25	9.63	76.25	7.36	74.56	9.16

[a] T Test, Group 1 vs Group A, p<0.001, [b] T Test, Group 1 vs Group A, p=0.028, [c] T Test, Group 2 vs Group A, p=0.028
[d] T Test, Group 1 vs Group A, p=0.016 , [e] T Test, Group 2 vs Group A, p=0.035, [f] T Test, Group 1 vs Group 2, p=0.023
BMI, Body Mass Index; R, Resistance; Xc, Reactance; PHA Phase Angle; BCM, Body Cell Mass; BCMI, Body Cell Mass Index; TBW, Total Body Water; ECW, Extra Cellular Water; ICW, Intra Cellular Water; FM, Fat Mass; FFM, Fat Free Mass.

TABLE 2 Anthropometric and body composition characteristics of Group A, Group 1 and Group 2.

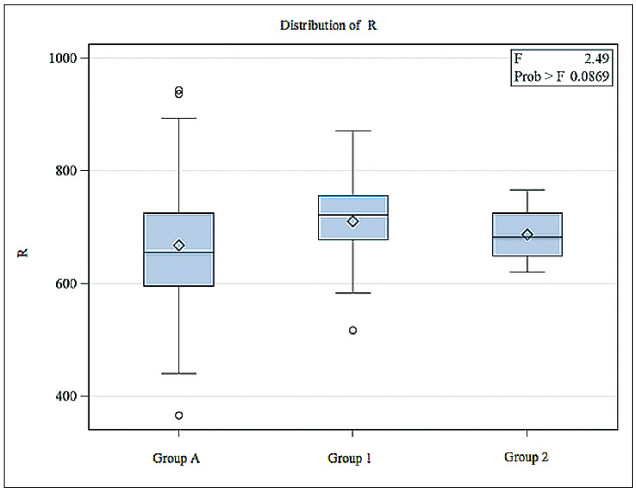


FIG. 1 Distribution of R in Group A, Group 1 and Group 2.

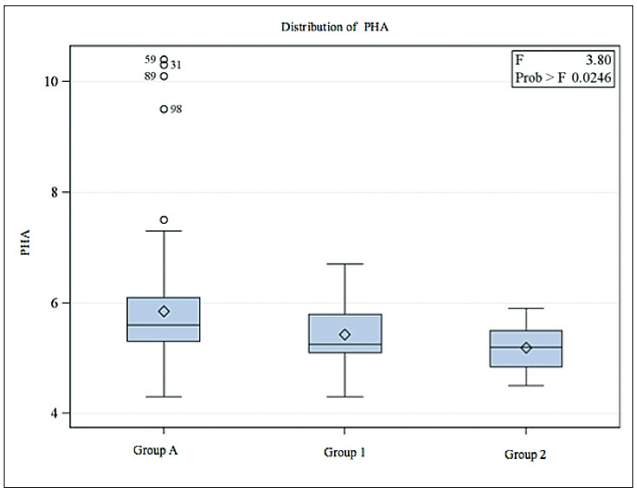


FIG. 2 Distribution of PHA in Group A, Group 1 and Group 2.

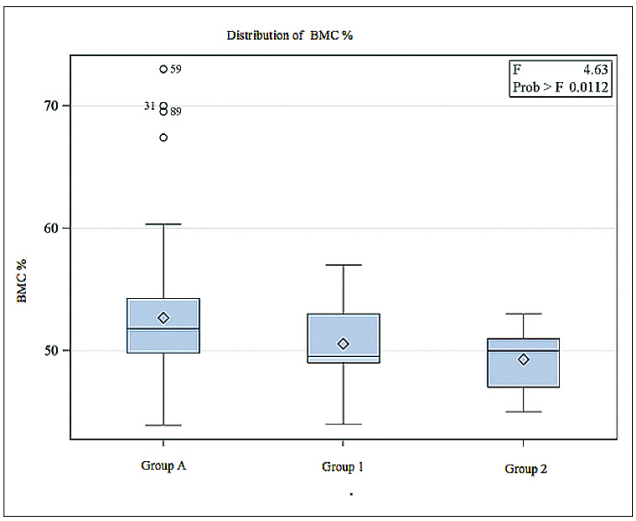


FIG. 3 Distribution of BMC% of Group A, Group 1 and Group 2.

Discussion

The scientific literature underlines that dental diseases [Moynihan and Petersen, 2004] in the developmental age, such as carious disease [Psoter et al., 2005; Dimaisip-Nabuab et al., 2018; Janakiram et al., 2018], periodontal disease [Martinez-Herrera et al., 2017], enamel hypoplasia [Sheetal et al., 2013], alteration of dental eruption times [Must et al., 2012; Dimaisip-Nabuab et al., 2018], and root dilaceration [Simsek et al., 2019], may be influenced by nutritional status.

Only a few studies have related the body composition of subjects in paediatric age and some dental pathologies [Costacurta et al., 2011; Salekzamani et al., 2011; Costacurta et al., 2014]. For this reason we wanted to investigate a dental pathology not yet analysed in other studies, namely dental agenesis, with the aim of evaluating the anthropometric parameters and the body composition of paediatric subjects suffering from dental agenesis compared to healthy subjects, through bioelectrical impedance analysis. Furthermore, whether there was a statistically significant difference in body indices between subjects suffering from single agenesis and those presenting multiple agenesis was assessed.

Anthropometric analysis and BIA were used for this study; the dual method used to study body composition provides different tools to assess the characteristics of the sample under examination [De Lorenzo et al., 2019].

The results show that some indicators (R, PHA, BCM%) present a statistically significant difference between the case and control groups. In particular, the BCM% index has a higher average value in the control group than in the group with single agenesis and in the group with multiple agenesis. These results would not be expected, also considering the fact that the case groups have a higher average age than the control group.

The BCM is the metabolically active part of the organism that contains rich potassium tissue, exchanges oxygen, oxidizes energy substrates and allows us to evaluate energy expenditure, protein needs and the metabolic response of the organism.

Lower BCM% values could probably be an indication of protein energy malnutrition (PEM), which should be analysed with more in-depth investigations, such as the study of inflammation factors, especially when it turns out that the aetiology of the disease was not genetic, so potential environmental factors could be involved.

The R index has a higher value in cases of single agenesis and in cases with multiple agenesis than in the control group. Body resistance (R or conductive resistance) refers to the ability of the body to oppose the passage of an electric current. The lower the water present in the tissue (e.g. bone, lipids) the higher the body resistance and vice versa. Therefore, since R is inversely proportional to the body's hydration, the results obtained would indicate that the subjects with agenesis are prone to dehydration compared to the group without agenesis. Dehydration could be caused by a lower amount of water at an extracellular level or by a smaller amount of muscle mass, since the latter is physiologically made up of a high percentage of water. Considering that ECW values showed no statistically significant differences between the case groups and that BCM% is an index associated with muscle mass, it is possible to hypothesise that the group with agenesis has a lower percentage of muscle tissue than the subjects without agenesis.

PHA measures the relationship between resistance and reactance, being a BCM% derivative, it has a lower average

value in groups with single and multiple agenesis compared to the control group. In a subject the PHA varies from 6° to 7°; low PHA values (less than 5°) are also associated with low reactances and often indicate a "rupture" of cell membranes or an abnormal accumulation of extracellular fluids, such as in cases of significant water retention or oedema [Di Renzo et al., 2012]. This index is directly proportional to muscle mass, therefore it is possible to hypothesise a lower quantity of muscle mass in subjects with agenesis compared to those in the control group. The BMCI, represents the cell mass ratio (BCM) with the height of the subjects squared: BCM (Kg)/ height (m^2), does not show significant differences according to the Student's T test, even if there is a certain tendency to be lower in the case groups.

From the analysis of the parameters that determine the nutritional status (BMCI, PHA, ECW), there were no cases of malnutrition, but a suspected PEM should be evaluated.

In a review by Sheetal on "Malnutrition and its oral outcome" it is stated that malnutrition can affect oral health, and that an alteration of oral health, in turn, can lead to malnutrition, generating an interdependent relationship [Sheetal et al., 2013]. Malnutrition can occur during an individual's life due to poor diet, but may also have an early onset in infancy or intrauterine life [Thomaz et al., 2010]. Malnutrition could alter oral homeostasis, reduce resistance to microbial biofilm, reduce tissue healing capacity, alter the process of dental mineralisation [Sheetal et al., 2013], times of dental eruption [Dimaisip-Nabuab et al., 2018; Psoter et al., 2008a] and the function of salivary glands [Psoter et al., 2008b]. According to some authors, malnutrition is also associated with dental caries [Dimaisip-Nabuab et al., 2018; Psoter, 2005].

Conclusion

In conclusion, the present study shows how body composition in subjects with agenesis has specific characteristics of a higher resistance, a consequent lower phase angle and a lower cell mass compared to the control group. For the first time our results highlighted the possible relationship between dental agenesis and body composition measured by BIA.

The results obtained could not be compared with other previous studies, because this type of evaluation is done for the first time in this study.

The limit of this work was not being able to use more sophisticated methods of assessing body composition, such as DXA. It would be interesting to increase the sample size of those with agenesis and to carry out an aetiological investigation of genetic factors (Pax 9, Axin 2) and an evaluation of inflammation factors (IL-6, IL-1, TNF-alpha) [Di Renzo et al., 2007; Di Renzo et al., 2008; Di Renzo et al., 2013] probably active in subjects affected by agenesis, given the data collected regarding the lower cell mass and, hypothetically, PEM.

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