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Use of Bioelectric Impedance Analysis (BIA) in Children with Alterations of Body Water Distribution

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Validation studies of bioelectric impedance analysis (BIA) were performed in children with obesity, Duchenne muscle dystrophy and juvenile rheumatoid arthritis. BIA allowed an accurate assessment of total body water in all groups (CV from 4.1 to 5.1%). However, the prediction of extracellular water by BIA was not always satisfactory (CV from 8.5 to 12.5%), being better in the groups of children with the lowest variability in body water distribution. © 1998 Elsevier Science Ltd. All rights reserved

Introduction

Bioelectric impedance analysis (BIA) allows a non-invasive assessment of total body water (TBW) and extracellular water (ECW). It is therefore an ideal technique for the assessment of body composition in children (Battistini *et al.*, 1992). However, the accuracy of BIA in children with alterations of body water distribution is unknown.

We report on the results of 3 studies of BIA performed in children with alterations of body water distribution (Bedogni *et al.*, 1996a, 1996b; Bedogni *et al.*, 1997).

Subjects and Methods

Thirty obese children, 12 with Ducheuue muscle dystrophy (DMD) and 39 with juvenile rheumatoid arthritis (JRA) were studied. A control group consisting of normal-weight children was employed in each of these studies.

Total body water (TBW) and extracellular water (ECW) were assessed by deuterium and bromide dilution, as described in detail elsewhere (Lukaski and Johnson, 1985; Wong *et al.*, 1989; Battistini *et al.*, 1995).

Bioelectric impedance (Z) was measured at frequencies of 5, 50 and 100 kHz (Human-1M Scan, Dietosystem, Milano, Italy). The impedance index (ZI) was calculated as height^2/Z (cm^2/Ω) at each of the employed frequencies.

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Results

The characteristics of the children are given in Table 1.

The clinical implications of the altered body water distribution of obese, DMD and JRA children have been discussed in detail elsewhere (Battistini *et al.*, 1995; Bedogni *et al.*, 1996a, 1996b).

Weight (Wt) was the best single predictor of TBW in all groups, with the exception of obese children, where ZI explained 4% more variance of TBW than Wt ($r = 0.956$, SEE = 1.8 l, CV = 7.8%). The higher predictive power of Wt with respect to ZI is not surprising because of the homogeneity of the study samples (Kushner, 1992). After correction for ECW, frequencies of 50 and 100 kHz gave comparable estimates of TBW from BIA.

After correction of ECW for TBW, a frequency of 5 kHz offered the best prediction of ECW from BIA in all groups. Wt and ZI at 5 kHz generally offered similarly accurate estimates of ECW.

However, ZI generally improved the predictiou of TBW and ECW wheu added to Wt as a predictor variable. The results of the regressions of TBW and ECW vs the association of ZI and Wt are given in Table 2.

Discussion

BIA allowed an accurate assessment of TBW in our studies of children with altered water distribution. The prediction of ECW was not always accurate, being better in the groups with the lowest variability iu ECW%. Further studies are needed to determine

Table 1. Characteristics of the children

	Obese	DMD	JRA
n	30 [25]	12 [15]	39 [23]
Age (yr)	10.5 ± 1.5 [11.0 ± 1.8]	11.6 ± 2.4 [11.5 ± 2.1]	11.8 ± 3.0 [10.1 ± 4.4]
Sex (M/F)	16/14 [13/12]	12/0[a] [15/0]	9/30[b] [9/14]
Weight (kg)	56.0 ± 11.0[c] [40.7 ± 11.3]	46.4 ± 18.6 [43.5 ± 11.3]	40.9 ± 12.2 [38.0 ± 16.5]
TBW% (%)	50.5 ± 3.7[c] [58.1 ± 2.3]	51.8 ± 2.8[d] [58.5 ± 5.9]	59.7 ± 2.4[f] [57.7 ± 2.7]
ECW% (%)	43.2 ± 2.6[c] [37.0 ± 7.2]	52.9 ± 5.6[c] [40.3 ± 6.4]	44.5 ± 4.6[g] [38.1 ± 7.9]
ECW:ICW	0.77 ± 0.08[g] [0.60 ± 0.18]	1.15 ± 0.25[c] [0.70 ± 0.23]	0.81 ± 0.16[g] [0.64 ± 0.21]

[a]DMD is an X-linked disease. [b]Reflects the higher prevalence of JRA in females. [c]$p < 0.05$; [d]$p < 0.01$; [e]$p < 0.001$; [f]$p < 0.005$; [g]$p < 0.0001$ vs value of controls, given in square brackets.

Abbreviations: DMD = Duchenne muscle dystrophy; JRA = Juvenile rheumatoid arthritis; TBW% = TBW per kg of body weight; ECW% = ECW per l of TBW; ECW:ICW = extra- to intra-cellular water ratio.

Table 2. Values of *r*, SEE and CV associated to the prediction of total body water (TBW) and extracellular water (ECW) by BIA vs deuterium and bromide dilution, respectively

	TBW[a]			ECW[b]		
	Obese	DMD	JRA	Obese	DMD	JRA
r[c]	0.973	0.995	0.994	0.908	0.960	0.947
SEE (l)	1.4	1.1	1.0	1.0	1.8	1.2
CV (%)[d]	5.1	4.2	4.1	8.5	12.5	12.0

[a]Bioelectric impedance measured at 100 kHz.
[b]Bioelectric impedance measured at 5 kHz.
[c]$p < 0.0001$ for values of *r*.
[d]Calculated as [SEE/(TBW or ECW by dilution) × 100].
Abbreviations: DMD = Duchenne muscle dystrophy; JRA = juvenile rheumatoid arthritis.

if frequencies < 5 kHz can improve the prediction of ECW in children.

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