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Short Communication

Nutritional Status in diabetic patients with foot ulcers: Bioelectrical Analysis in routine evaluation

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Abstract.
BACKGROUND AND AIMS: Ulceration of the foot in diabetes is common and disabling Diabetic Foot Ulcers (DFU) are a dangerous and invalidating complication of diabetes. Traditionally they are classified by their aetiology, but many other factors may affect their evolution. Anamnestic, anthropometric and laboratory criteria are recommended for evaluation of Nutritional Status. They are suitable in clinical practice, but we argue that they are unfit to identify Malnutrition in specific populations, as DFU patients. Aim of our study was to evaluate the nutritional pattern and some other clinical and laboratory parameters among the ones tested routinarly in ambulatorial setting in a group of type 2 diabetic patients with DFU to characterize and single out the most efficient parameters useful for diagnosis of malnutrition.
SUBJECTS AND METHODS: 23 non healing DFU subjects and 24 type 2 diabetic subjects without DFU, as control. For the evaluation of body composition we used bioelectrical impedance analysis (BIA 101 Akern ®). Phase Angle (pA) was pointed as a marker of extracellular/intracellular water rate and of body cell mass (BCM). We also recorded HbA1c, disease duration, Haemoglobin (Hb), Albumin, Total Proteins, Creatinin, C-Reactive Protein (CRP), BMI and any weight variation in the last two months.
RESULTS: No significant difference for Albumin, Serum Proteins, CRP, Creatinin, Hb was found. Only the pA was significantly reduced ($p = 0.001$) in DFU subjects. Furthermore, the distribution of BMI and Hb values in reference ranges do not differ in DFU group and in the control group.
CONCLUSIONS: The routine clinical and laboratory evaluation tests are not reliable to detect dynamic changes of the nutritional status in DFU subjects whereas bioelectrical measurements are useful in the evaluation of body cell mass changes in these subjects.

Keywords: Evaluation of Nutritional Status, Diabetic Foot Ulcers (DFU), malnutrition, Bioelectrical Impedance Analysis (BIA), body cell mass, phase angle

1. Background and aims

Ulceration of the foot in diabetes is common and disabling Diabetic Foot Ulcers (DFU) are a dangerous and invalidating complication of diabetes. Traditionally they are classified by their aetiology, but many other factors may affect their evolution. Age, self care, smoking, alcohol, metabolic control, anaemia, kidney failure, malnutrition concur to cause and maintain the ulcer. In particular malnutrition is frequent in this condition, but is easily overlooked in routine practice. In patients with DFU malnutrition is characterized by protein deficiency due to kidney and wound loss, neoglucogenesis from amino acids, unbalanced diet, particularly in kidney failure [1].

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Furthermore other factors may worsen metabolic state: excess of liver glucose production is observed in fasting and postprandial state [2], depending of glucagon/insulin unbalance; high levels of cytokines and cortisol show a low grade inflammation characterized by a catabolic muscular state with increased output of amino acids in bloodstream, metabolic rate and insulin resistance [3, 4]. Cytokines induce also a delay of gastric emptying with anorexia.

Anamnestic, antrhopometric and laboratory criteria are recommended for evaluation of Nutritional Status [5, 6]. They are suitable in clinical practice, but we argue that they are unfit to identify Malnutrition in specific populations, as DFU patients.

Aim of our study was to evaluate the nutritional pattern and some other clinical and laboratory parameters among the ones tested routinarly in ambulatorial setting in a group of type 2 diabetic patients with DFU to characterize and single out the most efficient parameters useful for diagnosis of Malnutrition.

2. Subjects and methods

We studied 23 non healing DFU subjects (15/8 M/F, age range 71 ± 9.8 yrs) with evidence of infection and without kidney failure or advanced complication (other than neuropathy) in Day Hospital setting. The ulcers were classified as 2-3 PEDIS Grade – mild-moderate Infection Severity [7, 8].

For the evaluation of body composition we used Bioelectrical Impedance Analysis (BIA 101 Akern). Phase Angle (pA) was pointed as a marker of extracellular/intracellular water rate and of Body Cell Mass [9]. We also recorded HbA1c, disease duration, Haemoglobin (Hb), Albumin, Total Proteins, C-Reactive Protein (CRP), BMI and any weight variation in the last two months. We collected a population of 24 type 2 diabetic subjects without DFU, as control, matched for age, BMI, disease duration and glucose control (HbA1c).

DFU patients data were successively stratified according to the WHO, SINPE, ASPEN, ESPEN Standard [10–13] for clinical diagnosis and management of nutritional status, to the reference range of laboratory tests; BIA data were stratified according to the manufacturer's indications (confidence interval 5°–8° for elderly subjects).

3. Results

The results are shown in Tables 1 and 2. Several parameters were evaluated and no significant difference for Albumin, Serum Proteins, CRP, Creatinin, Hb was found. Only the pA was significantly reduced ($p = 0.001$) in DFU subjects.

According to WHO standard, no DFU patient had a BMI lower than 19 (underweight); 6 (about 25%) were normal weight, 17 (75%) overweight or obese (Table 2 and Fig. 1); 10 (40%) had hypoalbuminaemia (<3.5 mg/dl,

Table 1
Results

	DFU		controls		
	m	ds	m	ds	
Age	71	9,8	70	8,3	n.s.
BMI	25.05	2.7	26,5	2.4	n.s.
HbA1c	7,5	2.0	7,35	1,9	n.s.
Disease duration	16	4	15,5	3,8	n.s.
Weight loss (8 weeks)	8/35				
Albumin	4,00	0.0	4,32	0.9	n.s.
Phase Angle (pA)	4.9	2,6	5,56	1,2	$P = 0.001$
Creatinin	1.0	0,2	0,93	0,2	n.s.
Hb	13.1	0,1	13,4	1,0	n.s.
Proteins	7.3	0.9	7,3	0.5	n.s.
CRP	0.55	0.3	0,29	0.4	n.s.

Table 2
Results

	DFU ($n = 23$)	Controls ($n = 24$)
BMI <18.9	–	–
19–24.9	6 (25%)	6 (25%)
25–29.3	10 (45%)	10 (45%)
>30	7 (30%)	8 (30%)
Albumin <2.5	1 (5%)	–
2.5–2.9	1 (5%)	2 (10%)
3.0–3.5	7 (30%)	6 (25%)
>3.5	14 (60%)	16 (65%)
Hb <11	6 (25%)	6 (25%)
11.1–12	5 (22%)	6 (25%)
12.1–13.9	10 (33%)	8 (30%)
>14	2 (20%)	4 (20%)

8 mild, 1 moderate, 1 severe); 6 (25%) had anaemia (Hb < 11 g/dl) and 8 (30%) referred weight loss in the last 8 weeks.

In the control group the same distribution was observed for BMI and Hb; hypoalbuminaemia occured in 8 subjects (about 35%) but with a lesser extent (no severe one: 6 mild, 2 moderate). 12 pts (50%) had a pA lower than 5° suggesting a low BCM: apart from 1, all were classified as normal weight or overweight, 1 was obese according to their BMI.

4. Conclusions

DFU subjects often present hypoalbuminaemia (40% of the sample) and short term weight loss (30% of the population); low Albumin values are reported also in 35% of the control non ulcer subjects; the distribution of BMI, and Hb values in reference ranges do not differ in the two groups.

We conclude that the routine clinical and laboratory evaluation tests are not reliable to detect dynamic changes of the Nutritional Status that happen in diabetic complicated patients as DFU ones; actual WHO BMI criteria as routine ranges for Albumin, Total Serum Proteins, Creatinin, Hb and CRP should be interpreted with caution to evaluate nutritional status in these subjects.

Furthermore, our results indicate that, irrespective of the actual BMI, Serum Albumin and Proteins, and Hb levels, DFU subjects present a significant reduction of pA vs a diabetic uncomplicated population of the same age and disease duration.

The use of raw bioelectrical parameters is increasing in clinical research and practise. Phase Angle is a marker of Fat Free Mass hydration: it is influenced by sex, and age and it directly shows changes in proportion between IC and EC spaces (ECM/BCM), which ideal proportions should be 1/1. Morover it is related with outcome and progression in many diseases [14, 15]. There are few published data on hydration and body composition changes that may occur in complicated longstanding diabetic subjects: in these conditions inflammation, insulin-resistance and hyperinsulinaemia, hyperglycaemia, renal impairment, dieting and polipharmacy can induce protein caloric malnutrition and sarcopenia 3,4; our results seem to confirm a nutritional and functional impairment in frail DFU patients and suggest that pA should be included in their evaluation together with traditional biochemical nutritional parameters.

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