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Original

Hip fracture prognosis: could bioimpedance be an alternative to conventional nutritional assessment?

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Abstract

Background: **Risk-factors for mortality in hip fractures encompass nutritional status, nominally body mass index, but not body composition. Given the difficulty of anthropometric assessment in bedridden patients a prospective study with bioimpedance analysis was designed.**

Methods: **Elderly patients with hip fracture were consecutively recruited. Biochemical tests, primitive bioimpedance measurements (resistance, reactance and phase angle) and follow-up till one year were targeted.**

Results: **Patients (N = 69, 81.2 ± 8.1 years old, 72.5% females) stayed in the hospital for 15.5 ± 17.1 days, and 18.8%(13/69) required further hospitalization during the ensuing months. Mortality was 11.6% within 30 days, coinciding with hospital mortality, and an additional 11.6% till one year, thus reaching 23.2%. Anemia, hypoalbuminemia and low transferrin, along with elevated glucose and urea were frequent, suggesting undernutrition with metabolic derangements. Reactance, urea and creatinine were different in patients suffering both early and late demise. Resistance, white blood cell count and osteoporosis were risk factors for early mortality only , and anemia exclusively for late mortality .**

Conclusions: **Primitive bioimpedance measurements, which had not been hitherto investigated , were prognostically related to early and late mortality. These markers of disease-related malnutrition and especially reactance should be further studied in patients unfit for anthropometric evaluation due to fracture and immobility.**

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Key words: *Hip fracture. Malnutrition. Bioimpedance analysis. Reactance. Body mass index. Morbidity. Mortality.*

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PRONÓSTICO DE LA FRACTURA DE CADERA: ¿PODRÍA LA BIOIMPEDANCIA SER UNA ALTERNATIVA PARA LA EVALUACIÓN NUTRICIONAL CONVENCIONAL?

Resumen

Antecedentes: **Los factores de riesgo para mortalidad en las fracturas de cadera involucran estado nutricional, nominalmente índice de masa corporal, pero no composición corporal. Considerandose la dificultad de evaluación antropométrica de pacientes acamados, un estúdio prospectivo con bioimpedáncia fue programado.**

Métodos: **Pacientes de mayor edad con fractura de cadera fueron consecutivamiente recrutados. Testes bioquímicos, medidas primitivas de bioimpedáncia (resisténcia, reactáncia, ángulo de fase) e seguimiento hasta un año fueron valorizados.**

Resultados: **Los pacientes (N = 69, 81,2 ± 8,1 años, 72,5% mujeres) quedaronse en el hospital por 15,5 ± 17,1 dias, y el 18,8% (13/69) necesitaron de hospitalización adicional en los meses siguientes. La mortalidad de 30 dias fué 11,6%, coincidiendo con la mortalidad hospitalária, con 11,6% adicionales hasta un año, alcanzando un total de 23,2%. Anemia, hipoalbuminemia e baja de transferrina, asimismo glucosa y urea elevadas, se observaron con frecuencia, compatibles con desnutrición e trastornos metabólicos. La reactáncia, urea y creatinina eran diferentes en pacientes con mortalidad precoz y tardia. La resisténcia, recuento de leucocitos y presencia de osteoporosis indicaron mortalidade precoz solamiente, y anemia solo la mortalidad de un año.**

Conclusiones: **Las medidas primitivas de bioimpedáncia, que no habian sido hasta el momento investigadas en ese contexto, mostraronse pronosticamiente relacionadas com mortalidad precoz y tardia. Estos marcadores y en especial la reactáncia merecen ser mas estudiados en pacientes donde la antropometria es difícil o imposible por razones de fractura y inmobilidad.**

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Palabras clave: *Fractura de cadera. Desnutrición. Análisis de bioimpedancia. Reactancia. Índice de masa corporal. Morbilidad. Mortalidad.*

Introduction

Several demographic, clinical, and nutritional findings are prognostically important for mortality after hip fracture in the elderly.[1-3] Besides osteoporosis which is believed to be the hegemonic predisposing factor, emphasis is often given to low body mass index,[3] however this is not an easy measurement in recumbent persons with major bone trauma. Not more than half of the hospitals adopt any modality of nutritional screening,[4] therefore BMI values from previous admissions are hardly an option. Reported or estimated heights are not reliable either[5] and traumatic edema may be a pitfall for weight interpretation, thus rendering BMI utilization questionable.

Bioimpedance analysis (BIA), though an accepted measurement of nutritional status and body compartments, has not been investigated in this context. In a prospective protocol, the hypothesis was that both early and late mortality could be associated with changes in BIA indices, especially with reactance which is sensitive to body fluid shifts.[6-9]

Methods

Sixty-nine consecutive patients were investigated, 34 with fracture of neck of femur and 35 with intertrochanteric lesion. Groups were demographically and metabolically well matched therefore they are analyzed together.

Inclusion criteria were age > 65 years (males and females) and informed consent. Exclusion criteria were sepsis, shock, coma, pathologic fracture, use of corticosteroids, previous operation of the hip, use of pacemaker or refusal to participate in the protocol. Informed consent was given by all patients or caregivers, and the protocol was approved by the Institutional Ethical Committee.

Questionnaires targeting demographics and comorbidities were used, and diagnosis was based on current treatment. Derived BIA compartments (lean body mass, body fat and total body water) were not part of the protocol, only primitive findings (resistance, reactance and phase angle),as weight and height would be required in the equation. Fracture risk assessment according to the WHO/FRAX algorithm was not computed either, due to lacking BMI.[1] The standard tetrapolar technique was applied at the healthy side of the body, after overnight fasting and voiding (BIA Quantum II, RJL Systems, Clinton Township, MI, USA). Serum albumin, transferrin, BUN, creatinine, along with hematologic counts were measured by automated methods. Principal end-points were 30-day and one year mortality. Results (mean ± SD or percentage) were compared by Chi-Square test, analysis of variance (ANOVA) or Student's "t " test as appropriate. Classification by tertiles for comparison of risk factors was also conducted.

Table I
General features of the population

Variable	*Results*
Gender (males)	27.5% (19/69)
Age (years)	81.2 ± 8.1
Diabetes	23.2% (16/69)
Hypertension	58.0% (40/69)
Osteoporosis	44.9% (31/69)
Length of stay (days)	15.5 ± 17.1
30-day deaths*	11.6% (8/69)
1-year deaths*	11.6% (8/69)
Total deaths	23.2% (16/69)
Rehospitalization**	18.8% (13/69)
Hb (g/dL)	11.1 ± 1.8
Platelets (mm^3)	169,283 ± 56,557
WBC (mm^3)	9,504 ± 3,343
Lymphocytes (mm^3)	1,542 ± 751
Glucose (mg/dL)	128 ± 58
Urea (mg/dL)***	41.4 ± 12.8
Creatinine (mg/dL)	0.9 ± 0.3
Transferrin (mg/dL)	196 ± 73
Albumin (g/dL)	3.4 ± 0.6
Resistance (Ohm)	525 ± 95
Reactance (Ohm)	35.9 ± 12.2
Phase angle (degress)	7.1 ± 0.4

(*) All deaths occurred in the hospital, 15.1 ± 8.9 days after operation; (*) Further hospital admission along the year of follow-up.

Results

Patients were mostly females , and arterial hypertension , osteoporosis along with diabetes were fairly prevalent. Nearly one fifth required additional admission during the ensuing 12 months, mostly because of falls and clinical problems.

Participants suffered from some degree of anemia, hypoalbuminemia and low transferrin. In contrast white blood cell count (WBC) tended to be elevated, consistent with acute trauma and inflammation. Nevertheless creatinine was normal, with no case above 2 mg/dL (table I).

Gender and age played no role in death rate, however diminished resistance ($P = 0.024$) and reactance ($P = 0.048$) adversely affected 30-day results. As expected, participants suffering from osteoporosis had a worse outlook too ($P = 0.006$).

One year mortality was linked to reactance ($P < 0.001$) and anemia ($P = 0.039$). Noteworthy findings concerned also BUN and creatinine, both of which interfered with early and total mortality ($P < 0.001$).

Figure 1 illustrates impact on one-year mortality according to reactance values, and for comparison those of creatinine as well.

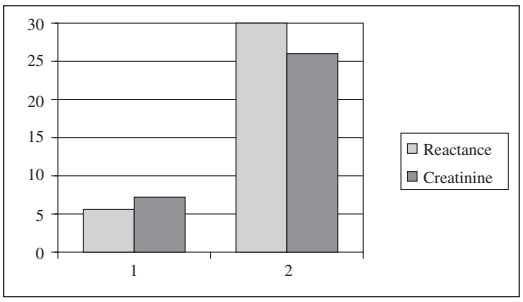

Fig. 1.—One-year mortality according to most versus least favorable tertile of reactance and creatinine. Columns represent observed mortality. Patients with high reactance exhibited markedly lower mortality (column 1) than those with diminished values (column 2). Only creatinine (along with BUN, not shown) displayed comparable prognostic association, however with opposite interpretation. Low creatinine concentration was protective (column 1) whereas elevation had ominous implications (column 2). P = 0.023 and 0.035, respectively.

Discussion

Proximal femoral fracture is the most severe low-energy trauma and the paramount complication of osteoporosis, as it tends to followed by morbidity, disability and particularly mortality.[1,2,10]

Recent studies unveil excess mortality not only during 12 months, but up to 10 years.[2,10] One is not dealing with an ordinary traumatic disorder, but with a cluster of abnormalities encompassing osteoporosis, frailty, impaired nutrition and organ dysfunctions.

In the WHO/Canadian series based on more than 46,000 subjects, osteoporosis was deemed relevant but not overarching, as mechanical fragility is only part of the context. Clinical risk factors were indispensable to develop a fracture risk assessment tool including prior fractures and family history, age, gender, body mass index, ethnicity, smoking, alcoholism, glucocorticoid use and rheumatoid arthritis.[1]

The importance of protein-energy compartments in these studies is underscored in a meta-analysis targeting BMI, with a total follow-up of over 250,000 person years.[3] Indeed, deranged nutritional status could underlie several of the alluded to comorbidities including alcoholism , rheumatoid arthritis and perhaps osteoporosis itself, notably in subjects with substantial weight loss.[11]

Frailty indexes, which robustly correlate with falls, fractures and mortality in this population ,also partly rely on weight loss history.[12]

Primitive bioimpedance measurements, nominally resistance and reactance, are weight-independent and thus ideal for bedridden patients. To the best of our knowledge, this is the first study to demonstrate that resistance and reactance could be employed for early as well as late mortality investigation.

Decreased resistance points toward underweight whereas low reactance signals body fluid shifts (overhydration),[6-9] conditions consistent with anemia, systemic inflammation and possible renal compromise as here demonstrated. Bioimpedance analysis could thus represent an advantage in comparison to classic anthropometrics (BMI, body weight changes), which do not distinguish between water retention or elimination and changes in fat and lean body mass.

In synthesis these variables, particularly reactance, are more specific for disease-related malnutrition,[9] and severely impaired mobility is not a deterrent to their adoption.

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