

Bioelectrical Impedance Analysis As A Screening Tool For Chronic Kidney Disease



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Introduction

- Chronic kidney disease (CKD) is a worldwide health problem with increasing incidence and prevalence.
- Diabetes is an important cause of renal disease.
- India has become the **Diabetes Capital** of the world with 61 million diabetics between the age of 20-79 suffering from this disease.

(Morrison AS: Screening in Chronic Disease, 2nd ed., New York, Oxford University Press, 1992).

Screening Test Characteristics

- The NKF-KDOQI guidelines recommend that individuals be screened for CKD using a spot urine for protein and an estimate of GFR based on serum creatinine.
- However, it is not clear that the recommended screening tests (spot urine) have characteristics acceptable for large-scale screening.

KDOQI CPG for CKD: KDOQI. Am J Kidney Dis 39 [2 Suppl 2]: S1-S246, 2002

Material And Methods

- Study Design: Community based cross-sectional study conducted on general population for screening hypertension and chronic kidney disease (CKD).
- Sample size: 52 subjects.
- Exclusion criteria: None
- Biochemical tests: 8 ml of blood.
- Statistical analysis was done using SPSS version 15.0 (SPSS Inc. Chicago, IL.).
- Data were not skewed.



Results

Medical History Was Taken On Validated Questionnaires

Disease	N = 52	Percent
Anemia	24	46.2%
Hypertension	20	38.5%
Diabetes Mellitus	07	13.5%
Renal Disease	04	7.7%
Gastrointestinal problems	14	46.1%
Acidity	10	19.2%
Reflux	03	25%
Ulcer	0	0%
Collitis	01	1.9%
Liver Disease	03	5.8%
Arthralgia	15	28.8%
Headache	02	3.8%
Hemiplegia	02	3.8%

DISCUSSION

- Chronic diseases like CKD typically have a variable latent period during which the disease is present but asymptomatic.
- Although it is not clear when CKD becomes symptomatic, substantial loss of renal function occurs before clinical events associated with CKD become apparent.

Hsu CY: J Am Soc Nephrol 13: 504-510, 2002

Thus, there is a substantial range of GFR during which patients with CKD, defined by a GFR less than 90 ml/min, may be asymptomatic and where **screening is justified**.

Conclusion

- Patients who develop radio contrast nephropathy (RCN) have greater mortality than those who do not.
- Accordingly, efforts to prevent or minimize RCN should be implemented in those with diabetes and CKD.
- Literature has shown that use of DTPA in elderly and those with compromised renal function can have adverse affect on renal function.
- The decreased clearance of DTPA causes decrease in function in the affected kidney.

Majd M, Potter BM, Guzzetta PC, Ruley EJ. J Nucl Med. 1983;24:23.

Introduction

- The KDOQI guidelines identify demographic groups, characterized by high incidence or prevalence of CKD as populations, that should be targeted for screening and intervention.

KDOQI CPG for CKD: KDOQI Am J Kidney Dis 39 [2 Suppl 2]: S1-S246, 2002

- Population-based programs to promote screening for CKD are intended to identify people with renal injury for intervention.

- The purpose of these programmes is that early intervention or treatment for patients with CKD will prevent morbidity and mortality and delay progression to end stage renal disease (ESRD).

(Morrison AS: Screening in Chronic Disease, 2nd ed., New York, Oxford University Press, 1992).

Bioelectrical Impedance Analysis

- Bioelectrical Impedance Analysis (BIA) is a technique that uses low voltage current which passes through cell membranes, water and fat.
- It quantifies water compartments, fat mass, lean body mass, and with the **use of serum creatinine BIA measures creatinine clearance and GFR**.
- It estimates dry weight which is required to estimate volume overload in CKD.



Demographic Profile Subjects From General Population

PARAMETER	MALE N = 22	FEMALE N = 30
Age (years)	51.3 ± 13.347	46.3 ± 13.02
Height (cm)	165.0 ± 7.30	154.2 ± 11.68
Weight (Kg)	68.6 ± 11.6	67.16 ± 16.7
BMI	24.92 ± 4.57 overweight	28.49 ± 6.18 overweight
Systolic Blood Pressure mmHG	133.99 ± 40.89	132.10 ± 16.20
Diastolic Blood Pressure mmHG	82.76 ± 27.79	83.46 ± 7.85
Serum Creatinine mg%	0.94 ± 0.14	0.91 ± 0.84
Urine Protein	2	2
BUN mg/dL	12.91 ± 3.69	11.27 ± 7.79
Hemoglobin g/dL	13.19 ± 1.79	11.75 ± 1.78
Random Blood Sugar mg%	109.63 ± 55.27	105.16 ± 39.90
Cholesterol mg%	192.95 ± 23.24	182.13 ± 28.59
Total Bilirubin mg%	0.71 ± 0.05	0.71 ± 0.14
SGPT U/L	27.7273 ± 17.26869	20.4333 ± 6.92663
SGOT U/L	26.95 ± 8.94	22.86 ± 5.41

Results BIA Parameters Of The Subjects

PARAMETER	Male (20)	Female (32)
TBW liters	37.23 ± 8.69	30.88 ± 5.23
TBW%	54.57 ± 8.80	46.09 ± 4.83
ECW liters	17.91 ± 9.41	12.80 ± 1.98
ECW%	46.40 ± 11.03	41.57 ± 2.44
ICW liters	19.64 ± 5.10	18.09 ± 3.46
ICW%	51.10 ± 14.84	57.09 ± 8.61
ECW/ICW	0.8151 ± 0.18657	0.7127 ± 0.07099
Creatinine clearance ml/min	97.39 ± 28.98	107.60 ± 34.03
GFR ml/min/1.73 m ²	74.11 ± 25.98	65.17 ± 21.14
Dry weight (kg)	67.75 ± 15.58	67.16 ± 16.47
Fat Mass (kg)	19.43 ± 9.74	29.08 ± 12.27

Discussion

- Major findings of this study are that in general population, **all the subject (100%) screened** had kidney disease, but they were neither symptomatic nor aware of it.

13.5% subjects were diabetics and 64% were hypertensive.

Out of 64% only 13.4% (07) were aware of hypertension and were on treatment.

Microalbuminuria which is an independent risk factor for the development of CKD and GFR loss was present in 7.0% which **further impresses upon the need for general population screening**.

BMJ 306:1235-1239, 1993

Conclusion

- The decreased clearance of DTPA causes decrease in function in the affected kidney.
- Although incidence is not known, but unusual tiredness or weakness cough, difficulty with swallowing, shortness of breath, wheezing, tightness in the chest dizziness, fast heartbeat, fever, hives, itching, swelling on face, skin rash are adverse effects **which can be prevented with use of BIA for estimating GFR**.
- In developing country like India, with detection of CKD at an early stage, appropriate interventions can prove cost effective and prevent complications and delay progression to ESRD.

Introduction

- GFR is the best overall index of kidney function for diagnosis and follow up of CKD.

Yildiz G. et al Minerva Med 2013 104:1-3

- It is calculated using different methods such as creatinine clearance (CrCL), ^{99m}Tc-DTPA, inulin, radioisotopes but these techniques are complicated, costly and time consuming and have potential side effects.

Zahran A Am J Nephrology 2007 27 (2) 197-205

Keane WF: PARADE Position paper of the NKF. AJKD 33: 1004-1010, 1999

Objectives

- To evaluate Applicability of Bioelectrical Impedance Analysis (BIA) as a screening tool for detecting kidney disease in general population using creatinine clearance and glomerular filtration rate (GFR).

Calibration/Validation Of BIA

Equipment: Tetrapolar single frequency Maltron BIOSCAN analyzer 915/916

Compared BIA derived TBW with TBW

derived using **Hume et al's equations** to check its accuracy in estimating water compartments.

TBW in men = -14.01 + 0.2968 * body weight + 0.1948 * Ht (cm)

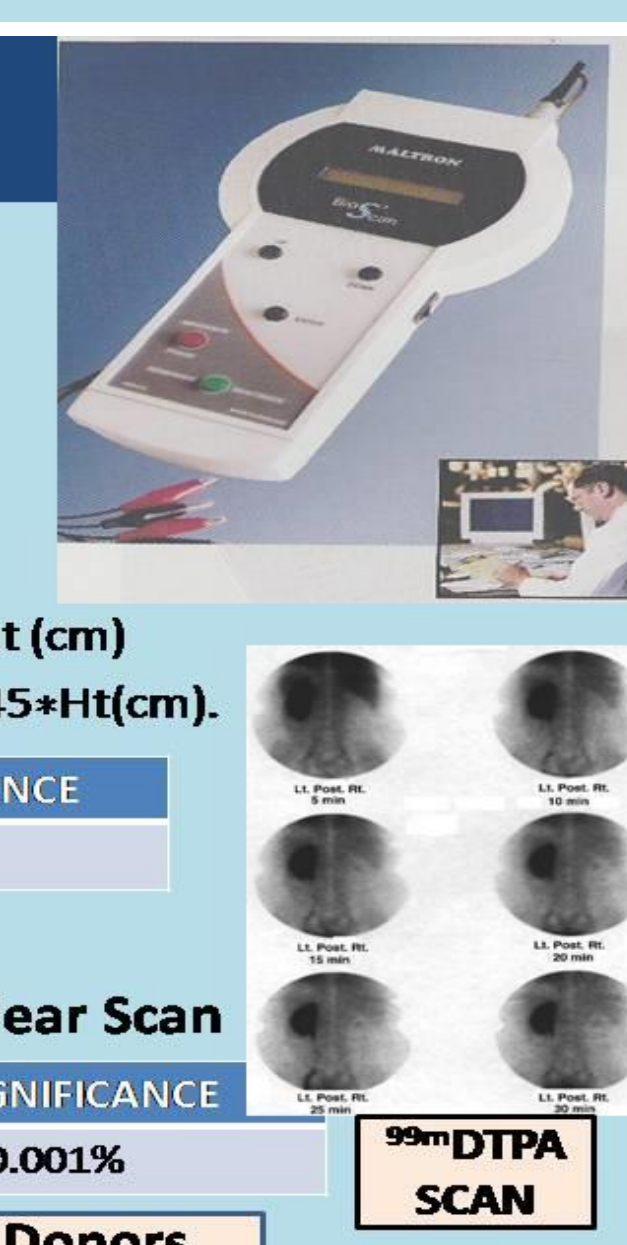
TBW in women = -35.27 + 0.1838 * body weight (kg) + 0.3445 * Ht (cm).

BIA TBW	HUME'S Equation TBW	P VALUE SIGNIFICANCE
33.7 ± 6.6 L	34.8 ± 6.18 L	0.189 At 0.001%

Compared BIA derived GFR vs ^{99m}Tc-DTPA Nuclear Scan

BIA derived GFR	^{99m} Tc-DTPA GFR	P VALUE SIGNIFICANCE
95.0 ml/min	95.0 ml/min	0.189 At 0.001%

Study done on Healthy Voluntary Kidney Donors



Based On BIA Derived GFR ml/min/1.73 m² Subjects Were Classified Into CKD Stages 1-5

Sex	CKD stage					Total
	>90	60-89	30-59	15-29	<15	
Male	4	12	5	1	0	22
Female	4	11	13	1	1	30
Total	8 (15.5%)	23 (44.2%)	18 (34.6%)	1 (1.9%)	1 (1.9%)	52

Blood Pressure Was Classified According To American Heart Association (AHA, 2013)

Mean Blood Pressure was 133.99 ± 40.89/82.76 ± 27.79 mmHG in males and 132.10 ± 16.20/83.46 ± 7.85 mmHG in females.

Normal BP	Prehypertensive Stage	Hypertension Stage 1	Hypertension Stage 2	Crisis Hypertension
Systolic <120 mmHG and Diastolic <80 mmHG	120-139 mmHG	140-159 and	>160 mmHG	BP >180 and
19 (36%)	08 (15.5%)	16 (30.7%)	6 (11.5%)	2 (3.8%)

BIA GFR versus Radionuclear GFR

- This study demonstrates that **if BIA instrument is validated against radionuclear method**, it is a handy and inexpensive tool for measuring GFR and screening CKD in general population.

Saxena et al SJKD 2014

Saxena et al CQN 2012

Saxena et al IJT 2013

- BIA can estimate GFR without use of radionuclear agents.

- According to KDOQI guidelines for screening and diagnosis of diabetic kidney disease caution should be used when administering radiographic contrast agents because their **risk of radio contrast induced nephropathy is higher (5% to 10%) than in those without these diseases (3.0%)**.

Parfrey PS et al NEJM 320:143-149, 1989



Thank you

