

HYDRATION STATUS ASSESSMENT IN CHRONIC KIDNEY DISEASE - COMPARISON OF DIFFERENT TECHNIQUES

Introduction

Fluid overload is a common phenomenon in patients with chronic kidney disease (CKD). Volume overload, even subclinical, is often present in chronic kidney disease (CKD) and, if left untreated, it leads to a poor control of hypertension and thus to a significant risk of cardiovascular disease.

Abnormal hydration status has been correlated with hypertension, as well as some symptoms and signs of left ventricular hypertrophy, congestive heart failure, pulmonary edema, peripheral edema, and other adverse cardiovascular outcomes. Thus, the accurate assessment of volume load is a daily challenge.

For clinical practice, evaluation of volume status is an important issue in patients with CKD. Physical examination is not enough to detect small increases in volume status efficiently. Small increases in volume status can be measured using multifrequency bioimpedance, which provides information on both hydration status and body composition. Whole-body multiple-frequency bioimpedance spectroscopy (BIS) appears to be a useful and appropriate technique for assessing hydration status and body composition in CKD patients.



Fig. 1. Probe placement for measurement of IVC diameter

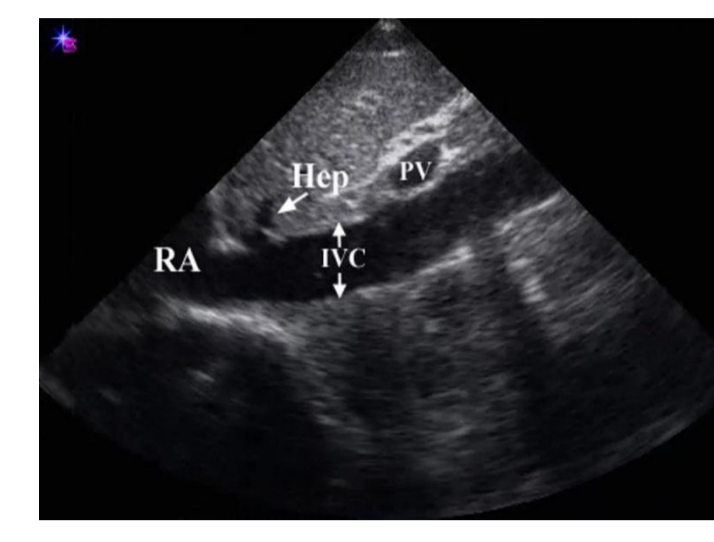


Fig. 2. Measurement of IVC diameter by US



Fig 3. Edema assessment by clinical exam



Fig. 4. Multifrequency bioelectrical impedance analysis

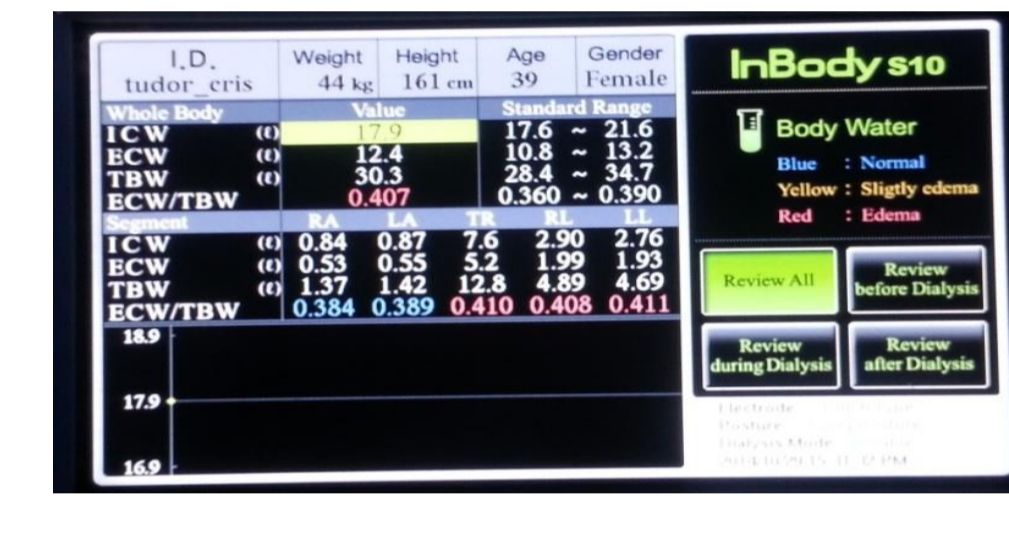


Fig 5. Multifrequency bioelectrical impedance chart

GFR category	GFR (ml/min/1.73 m2)	Terms
G1	≥90	Normal or high
G2	60-89	Mildly decreased
G3	30-59	Mildly to severely decreased
G4	15-29	Severely decreased
G5	<15 or dialysis	Kidney failure

Abbreviations: CKD, chronic kidney disease; GFR, glomerular filtration rate.

Table 1. GFR categories in CKD

Aims

The aim of our study was to determine the hydration status by using three different techniques: physical examination to assess edema, measurement of inferior vena cava (IVC) diameter by ultrasound (US) and multifrequency bioelectrical impedance analysis (MF-BIA).

Methods and Materials

During september-december 2014 we performed a **prospective study**.

Overt edema of the lower limbs was detected through physical examination by two different physicians and further classified into mild, moderate and severe.

On the day of the evaluation, a blood sample was drawn and the **serum creatinine and sodium** levels were determined.

The **IVC diameter** measurements were performed in the supine position with SonoAce Pico US device and 3.5 MHz convex probe. IVC was determined with transverse examination. Then probe was directed to longitudinal plane over IVC. The point where hepatic veins empties into the inferior vena cava was found by reducing the angulation. The distance between outer limit of the vessel and inner limit of the vessel at the opposite wall was measured 2 to 3 cm from the right atrial border in a long-axis/subxiphoid view.

Body fluid distribution was assessed by MF-BIA using InBody® S10 analyzer. MF-BIA estimated the extracellular water (ECW) to total body water (TBW) ratio, which represents edematous state if higher than 0.39.

The patients were categorized into stages 1 to 5 according to chronic kidney disease (CKD) staging in the NKF-K/DIGO guidelines.

Results

Demographic characteristics

62 patients were included (29 F, 33 M), mean age 59.6±14.5 (23 – 85 years).

Overt edema

- Edema was present in 27 (43.5%) patients (Chart 1).
- Incidence of overt edema was significantly higher in stage 5 CKD (56%) compared to stages 1-4 (44%, p=0.03) (Chart 2).
- The IVC diameter in patients without overt edema was significantly lower than the IVC diameter in patients with edema (17.1±2 mm vs 21.2±3.5 mm, p<0.01).

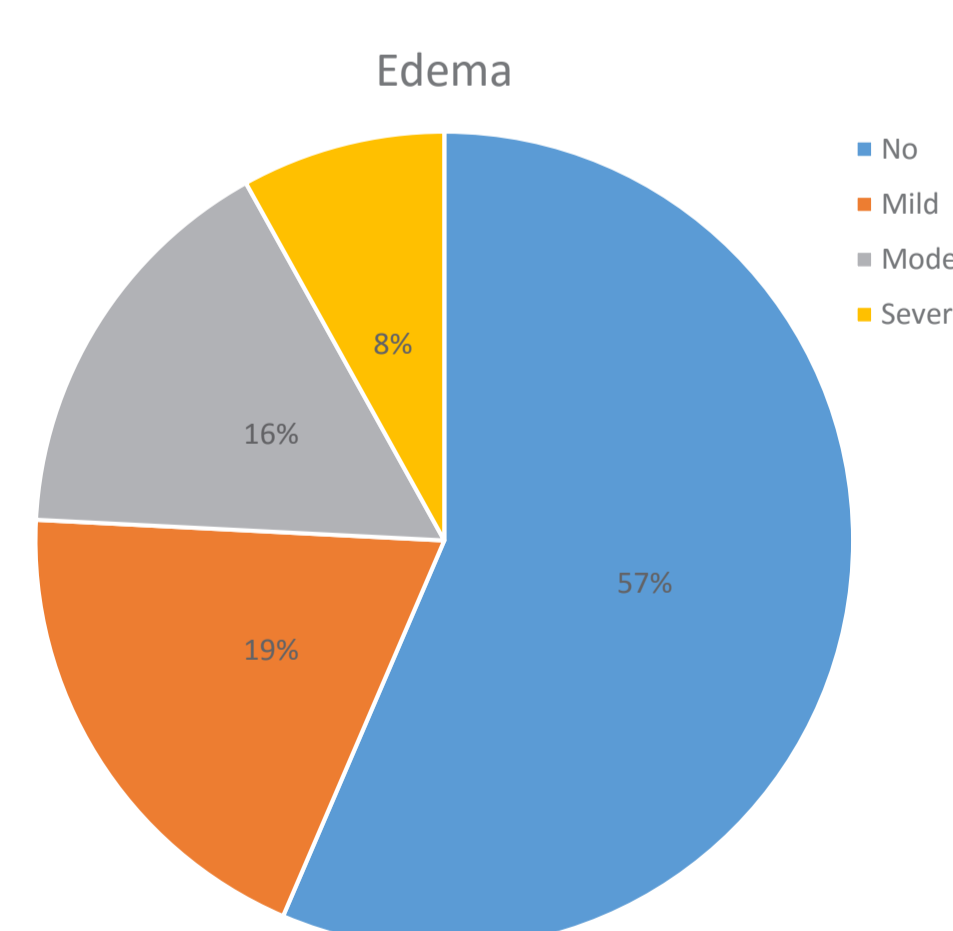


Chart 1. Presence and severity of overt edema

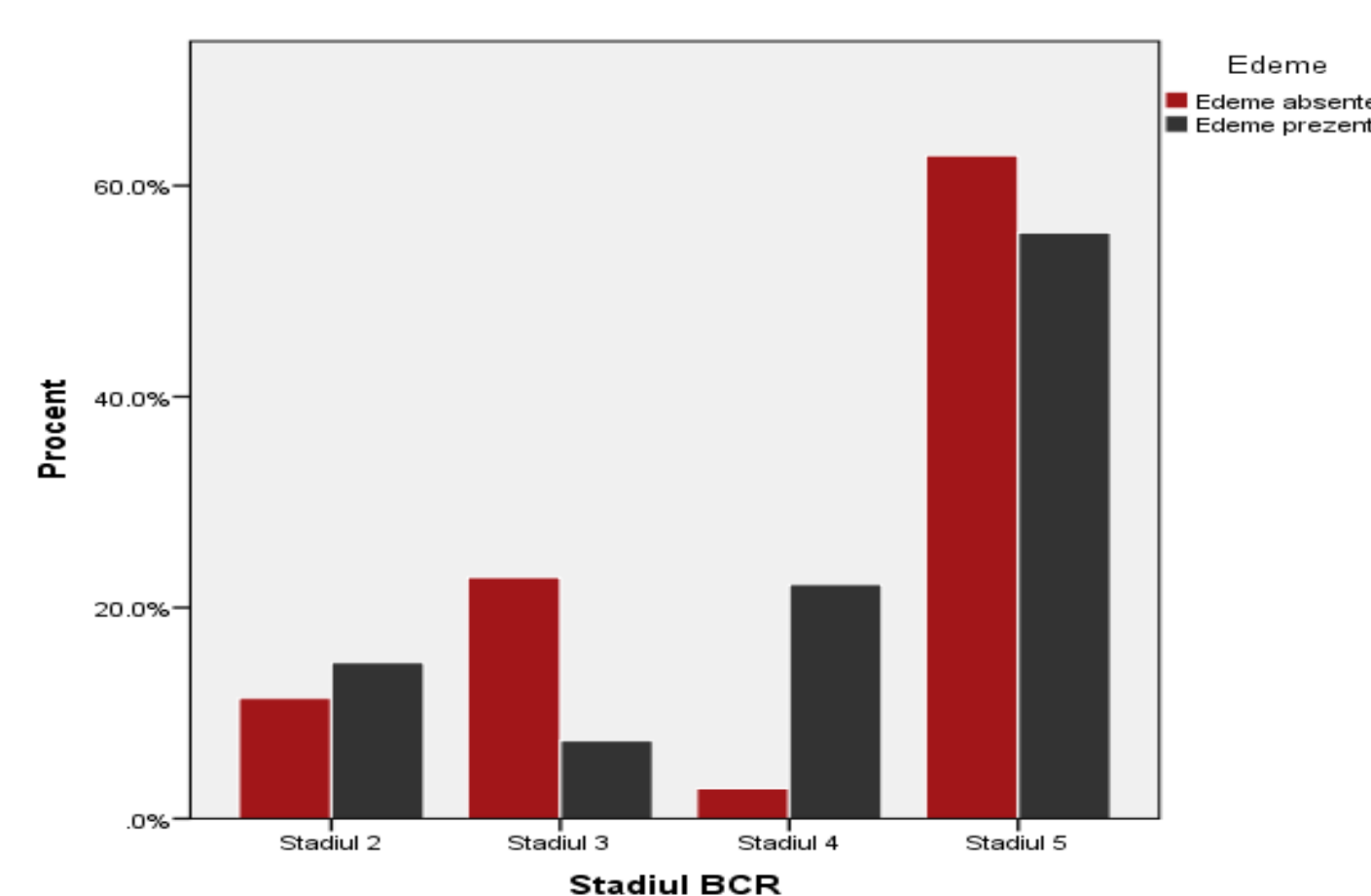


Chart 2. Incidence of overt edema depending on the stage of CKD

Results (continued)

Bioelectrical impedance analysis

- ECW/TBW measured by MF-BIA identified 38 patients (61.3%) with volume overload.
- 12 (34%) patients from the 35 without overt edema were diagnosed with subclinical edema according to MF-BIA
- Patients with overt edema had ECW/TBW significantly higher than those without edema (0.411±0,016 vs 0.389±0,008, p<0.001).
- Subjects with mild overt edema had ECW/TBW significantly lower compared with those with moderate and severe edema (0,398±0,011 vs 0,419±0,013, respectively 0,426±0,010, p<0,001).
- The IVC diameter in patients with normal ECW/TBW was significantly lower compared with patients with increased ECW/TBW (16.9±2.4 mm vs 20.2±3.4 mm, p<0.001).

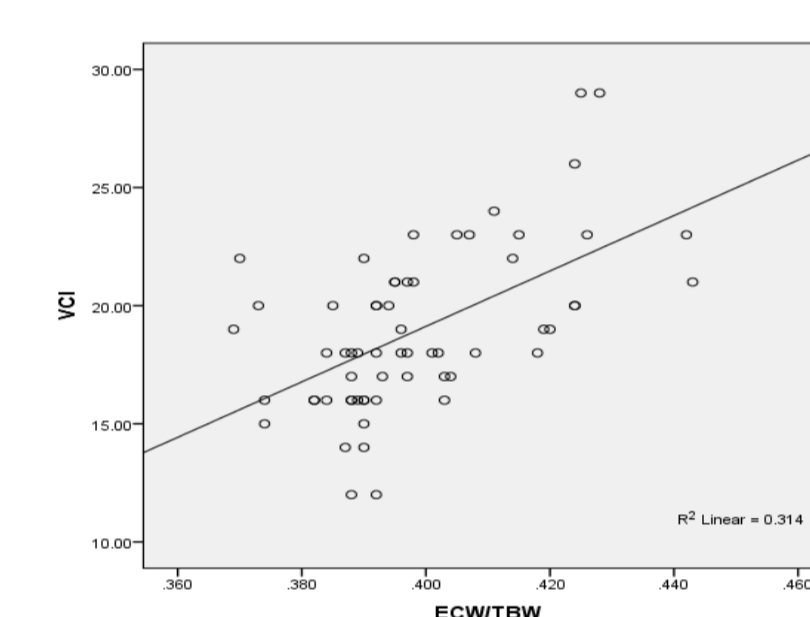


Fig 6. Positive correlation between IVC diameter and ECW/TBW

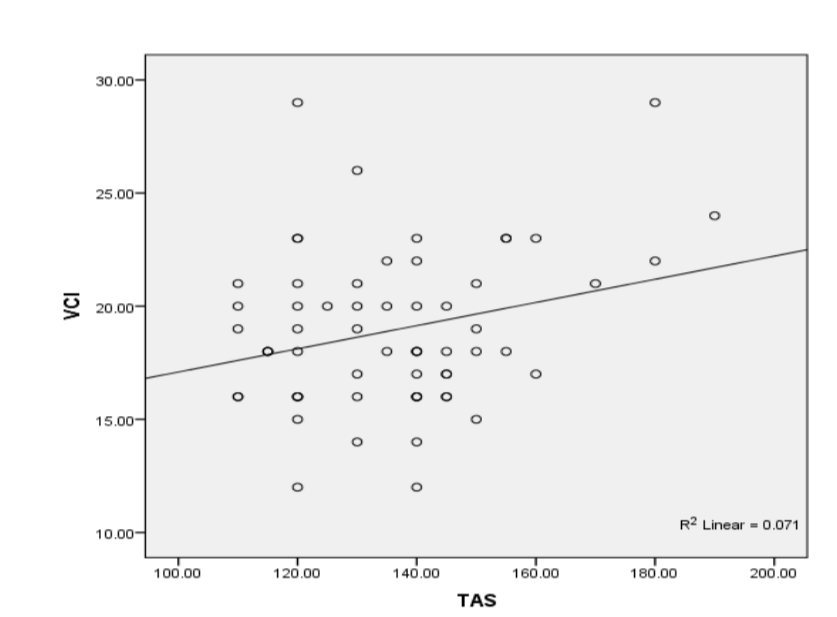


Fig 7. Positive correlation between IVC diameter and systolic arterial pressure

Hypertension

- Incidence of poor controlled hypertension was higher in patients with volume overload (p<0,001) (Chart 3).
- It was found a positive, but weak, correlation between systolic blood pressure and IVC diameter (Pearson coefficient 0,266, p=0.03), and ECW (Pearson coefficient 0,253, p=0.04).

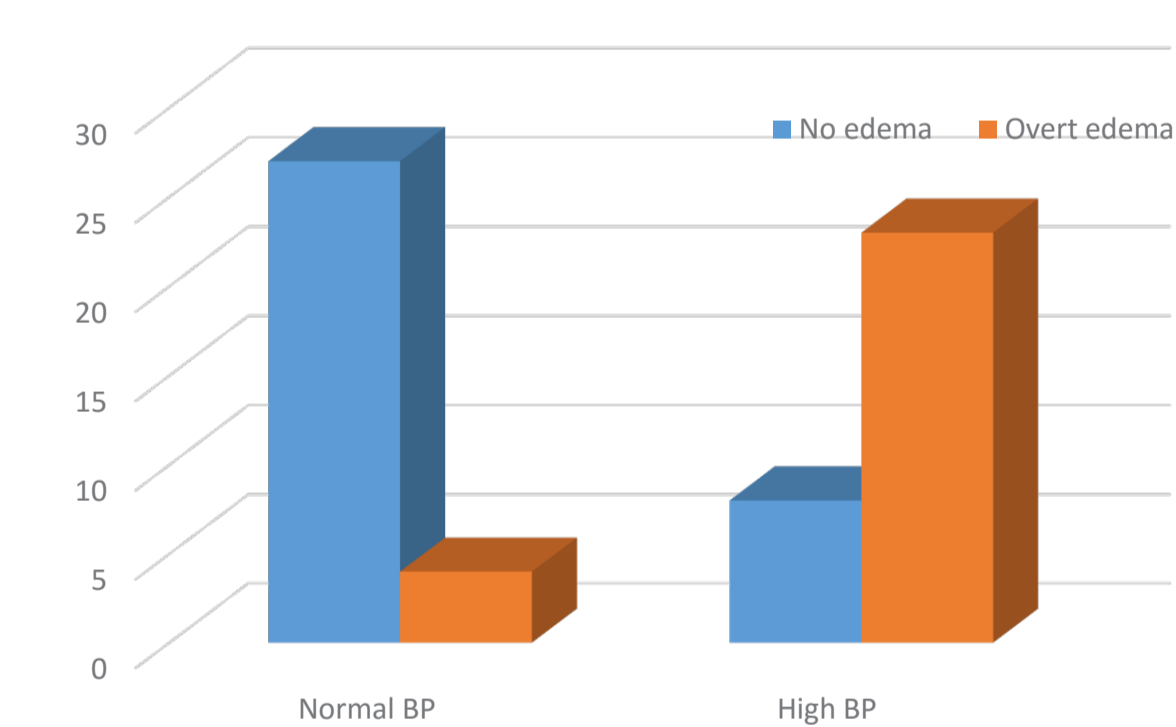


Chart 3. Incidence of poor controlled hypertension depending on the presence of edema

Conclusions

Our study proves that evaluation of hydration status by MF-BIA is a reliable measure of fluid status in CKD.

Subclinical edema is often present in CKD, before its detection by physical exam.

Incidence of poor controlled hypertension is higher in patients with volume overload.

An isolated systolic arterial hypertension, an IVC diameter higher than 20 mm or an ECW/TBW ratio higher than 0.39 must raise awareness regarding a possible fluid overload requiring prompt management.

References

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