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Fasting insulin level and Homatest IR as predictors of acute kidney injury in critically ill patients

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Abstract

Background: Kidney dysfunction is a major cause of morbidity and mortality whose prevalence, mainly because of population ageing, is rising worldwide. Also the epidemics of abnormalities clustering with insulin resistance might have played a role in increasing the prevalence of kidney dysfunction. Insulin resistance has been associated with increased risk of cardiovascular events and mortality in multiple large community-based cohort studies.

Objective: The aim of the study is to prove that insulin resistance not only may have a role in the development of chronic kidney disease but also may have a role in acute kidney injury.

Methods: This was a case-control study. The cases of the study were taken from the medical intensive care unit (ICU) of the Faculty of Medicine Cairo University, 100 control patients stratified by age and gender and 219 critically ill ICU patients with AKI.

Results: In the current study, we find that there is statistically significant higher fasting insulin levels and higher levels Homa IR in patients with AKI than patients without AKI. These results signify that patients with AKI had insulin resistance. In our study, the Homa IR showed non-significant correlation with APACHE and SOFA score. While fasting insulin level shows significant correlation only with SOFA score after 96 h.

Conclusion: Our present observations indicate that patients with acute kidney injury have statistically significant higher insulin resistance.

Keywords: Acute kidney injury, Fasting insulin level, Homatest IR

Introduction

Kidney dysfunction is a major cause of morbidity and mortality whose prevalence, mainly because of population ageing, is rising worldwide (Yoshio et al. 2011). Also, the epidemics of abnormalities clustering with insulin resistance (Reaven 1988) might have played a role in increasing the prevalence of kidney dysfunction (Chen et al. 2004).

Insulin resistance has been associated with increased risk of cardiovascular events and mortality in multiple large community-based cohort studies (Shinohara et al. 2002; Howard et al. 1996; Hedblad et al. 2002; Rutter et al. 2005; Zethelius et al. 2005).

Our hypothesis is that insulin resistance not only may have a role in the development of chronic kidney disease but also may have a role in acute kidney injury.

Study design

All adult (age ≥ 18 years) ICU patients with AKI in whom a nephrology service consultation was received were considered for the study. A total of 319 patients

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were enrolled in the study. Fasting insulin level was done to all of these patients and also Homa IR test for insulin resistance.

This was a case-control study. The study was done in the medical intensive care unit (ICU) of the Faculty of Medicine Cairo University, 100 control patients stratified by age and gender and 219 critically ill ICU patients with AKI.

Methodology

Included patients were subjected to the following: written consent (by the patient or his relatives); detailed history; full clinical assessment; laboratory tests on admission and follow-up including urea, creatinine, sodium, potassium, random blood sugar, complete blood count, coagulation profile, and liver function tests; fasting insulin level; and Homa test IR.

Estimation of IR was done using HOMA-IR which was calculated as fasting glucose (mmol/L) fasting insulin (mU/mL)/22.5. According to the instructions of the manufacturer, samples were collected in the morning after 12 h fasting. The collected samples were centrifuged, and the plasma was separated from the cells. Samples were assayed immediately or stored at − 70 °C or below.

Data management and analysis

The collected data was revised, coded, tabulated, and introduced to a PC using Statistical package for Social Science (SPSS 25). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

i. *Descriptive statistics*:

1. Mean, standard deviation (± SD) and range for parametric numerical data, while median and interquartile range (IQR) for non-parametric numerical data.
2. Frequency and percentage of non-numerical data.

ii. *Analytical statistics:*

1. Student's *t* test was used to assess the statistical significance of the difference between two study group means.

Results

Results for lab investigations between control and case groups are shown in Table 1, and the correlation between fasting insulin level and Homa IR test with APACHE and SOFA score are shown in Table 2.

Discussion

More than one study suggest that there is relation between insulin resistance and kidney disease employed hyperinsulinemic, euglycemic clamps in nondiabetic CKD subjects and compared the glucose disposal rate to

Table 1 Lab investigations between control and case groups

	Group				Student's ***t*** test	
	Control		Case			
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	***P***-value	Sig.
Urea	13.19 ± 2.44	13 (11–15.5)	157.45 ± 89.49	140 (100–200)	< 0.001$^{(M)}$	S
Creatinine	0.75 ± 0.09	0.7 (0.7–0.8)	5.42 ± 3.43	4.7 (2.8–6.6)	< 0.001$^{(M)}$	S
Uric acid	4.67 ± 0.52	4.5 (4.1–5.2)	9.75 ± 8.56	8 (6.8–11.55)	< 0.001$^{(M)}$	S
ALT	19.15 ± 2.51	18 (17–23)	92.85 ± 209.27	28 (15–73)	< 0.001$^{(M)}$	S
AST	19.92 ± 5.32	20 (15–23)	119.41 ± 258.76	37 (23–98)	< 0.001$^{(M)}$	S
Hb	12.84 ± 0.69		9.4 ± 2.62		< 0.001	S
WBCs (× 10_3)	5.91 ± 1	6.4 (5.4–6.7)	14.46 ± 16.44	12.5 (8.2–17.2)	< 0.001$^{(M)}$	S
Platelet (× 10_3)	349.73 ± 55.85	341 (312–399)	206.16 ± 130.21	184 (103–290)	< 0.001$^{(M)}$	S
Fasting glucose mg/dl	89.19 ± 4.14		98.37 ± 7.13		< 0.001	S
Fasting insulin level	18.19 ± 1.04		52.54 ± 15.81		< 0.001	S
Homatest IR	4.01 ± 0.28		12.73 ± 3.89		< 0.001	S
CRP (mg/dl)	0.83 ± 0.59	0.75 (0.3–1.2)	94.51 ± 102.77	56 (25–127)	< 0.001$^{(M)}$	S
Alb/cr in urine	8.27 ± 1.17	7.9 (7.8–8.9)	27.4 ± 20.56	22.4 (8.5–44.7)	< 0.001$^{(M)}$	S
Flow mediated dilatation of the brachial artery	11.67 ± 1.26		7.31 ± 0.75		< 0.001	S

$^{(M)}$Mann-Whitney test of significance

Table 2 Correlation between fasting insulin level and Homa IR test with APACHE and SOFA score

		APACHE score	APACHE mortality %	SOFA 0	SOFA 48 h	SOFA 96 h
Fasting insulin level	Pearson correlation	− 0.063	− 0.050	− 0.058	− 0.090	− 0.162
	p value	0.354	0.463	0.394	0.184	0.042
	Sig.	NS	NS	NS	NS	S
Homatest IR	Pearson correlation	− 0.057	− 0.044	− 0.050	− 0.098	− 0.144
	p value	0.404	0.520	0.462	0.149	0.071
	Sig.	NS	NS	NS	NS	NS

controls (DeFronzo et al. 1981). The presence of insulin resistance in CKD patients without diabetes was observed. Over time, a number of other groups made similar observations regarding the development of insulin resistance at various stages of CKD independent of the presence of type 2 diabetes (Shinohara et al. 2002; Becker et al. 2005; Landau et al. 2011). In one study of a CKD population, insulin resistance was evident in earlier stages of CKD, and yet, there were no differences in insulin sensitivity measures between the patients. This observation suggests that CKD itself, rather than the underlying specific disease process, was driving the systemic insulin resistance (Fliser et al. 1998).

Former studies were done in patients with chronic kidney disease while our study was done on patients with acute kidney injury.

In the current study, we find that there is statistically significant higher fasting insulin levels (52.54 pmol/l ± 15.81) (p value 0.021) and higher levels Homa IR (p value 0.027) in patients with AKI than patients without AKI whom fasting insulin level and Homa IR were 18.19 ± 1.04 pmol/l, 4.01 ± 0.28; these results signify that patients with AKI had insulin resistance (Table 1).

In our study, the Homa IR showed non-significant correlation with APACHE and SOFA score (Table 2), while fasting insulin level shows significant correlation only with SOFA score after 96 h (p = 0.042).

Conclusion

Our present observations indicate that patients with acute kidney injury have statistically significant higher insulin resistance.

Study limitation

As our study is a pilot study, there are little references and similar studies of this topic, so more studies are needed.

Abbreviations

ICU: Intensive care unit; AKI: Acute kidney injury; SPSS: Statistical package for Social Science; IQR: Interquartile range; SD: Standard deviation; IR: Insulin resistance; Alb: Albumin; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; Hb: Haemoglobin; WBC: white blood cells; CRP: C reactive protein; CKD: Chronic kidney disease; APACHE: Acute Physiology and Chronic Health Evaluation

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Authors' contributions

All authors have contributed significantly to the conception and design of the study, the interpretation of data, and the drafting and revision of the manuscript. All authors read and approved the final manuscript. Ahmed Fayed (patient selection) Ahmed Soliman (data collection) Mohamed Badr (idea of research and statistics) Mohamed Abdelmoniem (idea of research) Hesham Darwish (editing the research) Mohamed Fakher (data analysis) Mahmoud Salem Soliman (labs)

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Availability of data and materials

The datasets supporting the results are included within the article.

Ethics approval and consent to participate

The manuscript does not contain studies involving human participants, human data, or human tissue.

Consent for publication

The authors declare that the work has consent for publication

Competing interests

The authors declare that they have no competing interests.

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