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ACUTE KIDNEY INJURY IN OBESE PATIENTS WITHIN THE POSTOPERATIVE PERIOD OF MYOCARDIAL REVASCULARIZATION

LESÃO RENAL AGUDA EM OBESOS NO PÓS-OPERATÓRIO DE REVASCULARIZAÇÃO DO MIOCÁRDIO

LESIÓN RENAL AGUDA EN OBESOS EN EL POSTOPERATORIO DE REVASCULARIZACIÓN DEL MIOCARDIO

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ABSTRACT

***Objective*:** to identify whether there is a relation between obesity and the occurrence of acute kidney injury (AKI) in patients within the post-operative period of myocardial revascularization. ***Method*:** quantitative, longitudinal, and prospective study conducted at the general surgical intensive care unit (ICU) in a private tertiary hospital with 57 patients. We adopted a structured questionnaire for data collection. A descriptive and inferential data analysis was performed. Results with $p < 0.05$ were considered significant. ***Results*:** most of the patients were elderly (63±9 years). More than half of the obese patients evolved significantly with kidney injury or renal failure ($p = 0.01$). The surgery time in obese patients was higher ($p = 0.01$). The severity index Acute Physiology and Chronic Health Evaluation (APACHE II) was higher in overweight patients when compared to obese patients ($p = 0.01$). ***Conclusion*:** there was a relation between obesity and the occurrence of AKI. Thus, an increased understanding of this relation may guide health professionals, including nurses, in the preparation of preventive measures and, consequently, improve the population's quality of life, besides reducing costs to the health system. ***Descriptors*:** Obesity; Acute Kidney Injury; Thoracic Surgery; Body Mass Index; Intensive Care Units; Disease Prevention.

RESUMO

Objetivo: identificar se há relação entre obesidade e a ocorrência de lesão renal aguda (LRA) em pacientes no pós-operatório de revascularização do miocárdio. ***Método:*** estudo quantitativo, longitudinal e prospectivo realizado na unidade de terapia intensiva (UTI) cirúrgica geral de um hospital terciário privado, com 57 pacientes. Adotou-se um questionário estruturado para a coleta de dados. Realizou-se análise descritiva e inferencial dos dados. Resultados com $p < 0,05$ foram considerados significativos. ***Resultados:*** a maioria dos pacientes era idosa (63±9 anos). Mais da metade dos pacientes obesos evoluíram de forma significativa com lesão ou falência renal ($p = 0,01$). O tempo cirúrgico em pacientes obesos foi superior ($p = 0,01$). O índice de gravidade Acute Physiology and Chronic Health Evaluation (APACHE II) foi maior nos pacientes com sobrepeso quando comparado aos obesos ($p = 0,01$). ***Conclusão:*** houve relação entre obesidade e a ocorrência de LRA. Assim, o aumento da compreensão dessa relação pode orientar profissionais da saúde, inclusive enfermeiros, na elaboração de medidas de prevenção e, consequentemente, melhorar a qualidade de vida da população, além de diminuir os custos ao sistema de saúde. ***Descritores:*** Obesidade; Lesão Renal Aguda; Cirurgia Torácica; Índice de Massa Corporal; Unidades de Terapia Intensiva; Prevenção de Doenças.

RESUMEN

***Objetivo*:** identificar si existe una relación entre obesidad y la aparición de lesión renal aguda (LRA) en pacientes en el postoperatorio de revascularización del miocardio. ***Método*:** estudio cuantitativo, longitudinal y prospectivo realizado en la unidad de cuidados intensivos (UCI) quirúrgicos general de un hospital terciario privado con 57 pacientes. Se adoptó un cuestionario estructuradoatorio para la recogida de datos. Se realizó un análisis descriptivo e inferencial de los datos. Resultados con $p < 0,05$ se consideraron significativos. ***Resultados*:** la mayoría de los pacientes eran ancianos (63±9 años). Más de la mitad de los pacientes obesos evolucionaron significativamente con lesión o insuficiencia renal ($p = 0,01$). El tiempo quirúrgico en pacientes obesos fue mayor ($p = 0,01$). El índice de gravedad Acute Physiology and Chronic Health Evaluation (APACHE II) fue mayor en pacientes con sobrepeso en comparación con obesos ($p = 0,01$). ***Conclusión*:** hubo una relación entre obesidad y la aparición de LRA. Así, una mayor comprensión de esta relación puede orientar a los profesionales de la salud, incluyendo enfermeros, en la preparación de medidas preventivas y, en consecuencia, mejorar la calidad de vida de la población, además de reducir los costos para el sistema de salud. ***Descriptores*:** Obesidad; Lesión Renal Aguda; Cirugía Torácica; Índice de Masa Corporal; Unidades de Cuidados Intensivos; Prevención de Enfermedades.

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INTRODUCTION

Obesity is regarded as an increasingly relevant clinical and socioeconomic problem in developed and developing countries. Its prevalence has almost doubled within the last 20 years[1], determining a major impact on health systems.[2-3]

Renal dysfunction, as a chronic inflammation condition[4], can be determined both by insulin resistance, arterial hypertension, and cardiovascular diseases and by hypoventilation due to obesity.[1,5]

Obesity is identified as a global public health issue, considered a risk factor for a broad spectrum of cardiovascular disorders and, consequently, this is an increasingly prevalent characteristic in patients undergoing cardiac surgery.[6]

Due to the prevalence of obesity, estimated at 25% in an intensive care unit (ICU), various studies were conducted within the last 10 to 15 years.[7-8] Nevertheless, there are uncertainties about the relation between increased body mass index (BMI) and complications resulting from cardiac surgery[9], on the other hand, although scientific evidence shows an association between obesity and chronic kidney disease (CKD), it is not widely accepted as a risk factor for acute kidney injury (AKI).[10-1] The physiopathology of AKI associated with obesity is not completely understood. Thus, the relation between obesity and the occurrence of AKI after cardiac surgery is argued about. However, factors related to obesity combined to other comorbidities translated by hypotension, use of nephrotoxins or sepsis may be associated with a greater predisposition to AKI.[12]

AKI accounts for about 7% of the hospitalized patients and 7.5% of those undergoing surgery, except for cardiac surgery.[13] However, up to 30% of around 1 million people per year, worldwide, admitted to heart surgery, develop AKI and, depending on severity, 10% to 60% evolve to death.[14]

The relevance of AKI as a major problem in hospitalized patients is unquestionable, given its association with severe complications, early and late mortality[15], as well as increased health care expenditures.[16] On the other hand, since AKI is a potentially preventable condition, it is key to identify possible determinant conditions for the projection of effective preventive strategies.

OBJECTIVE

- To dentify whether there is a relation between obesity and the occurrence of acute kidney injury in patients within the post-operative period of myocardial revascularization.

METHOD

This is a quantitative, observational, longitudinal, and prospective study conducted at the general surgical ICU in a private tertiary hospital, specialized in cardiology in the Brazilian Federal District.

The convenience sample consisted of 57 adult patients, followed up during the 10-day hospitalization period to analyze the evolution profile. Patient's outcome at discharge from the hospital and the ICU was assessed.

Patients aged 18 years or older were included, those undergoing elective myocardial revascularization surgery with or without extracorporeal circulation, creatinine clearance greater than 60 mL/min/1.73 m^2, calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD- EPI) formula.[16] Those who underwent combined surgery or other types of cardiac surgery were excluded.

Patient inclusion has considered the baseline serum creatinine, i.e. that observed at hospital admission, in the case of its absence, we assumed as baseline serum creatinine the lowest value obtained within the first week of ICU admission.

Data were collected by means of a structured questionnaire containing patients' clinical and sociodemographic identification items, hemodynamic, surgical, and biological parameters.

For daily assessment of renal function, the serum creatinine recommended by the Kidney Disease Improving Global Outcome (KDIGO) classification has been adopted. This classification allows staging the renal function through serum creatinine and urine output, thus the stage 1 or risk for kidney injury was the stratification of a patient showing a 1.5 to 1.9-fold increase in baseline creatinine or a 0.3 mg/dL increase and/or urine output lower than 0.5 mL/kg/h for 6 to 12 hours. A 2.0 to 2.9-fold increase in baseline creatinine and/or urine output lower than 0.5 mL/kg/h for a time greater than or equal to 12 hours has been characterized as stage 2 (kidney injury). Finally, stage 3 (renal failure) occurred if the patient showed a 3.0-fold increase in baseline creatinine or a 4.0 mg/dL increase or the onset of dialysis in patients aged under 18 years with creatinine clearance lower than 35 mL/min/1.73 m^2 and/or urine output lower than 0.3 mL/kg/h for a time greater than or

equal to 24 hours or anuria for a time equal to or greater than 12 hours.[17]

The Acute Physiology and Chronic Health Evaluation (APACHE II) index has been adopted to analyze patient severity, which represents a scoring system to determine the extent of impairment or the organ failure rate. The score is based on 6 variables relevant to the respiratory, cardiovascular, hepatic, hematopoietic (coagulation), renal, and neurological systems.[18]

A patient is considered obese when showing a BMI greater than or equal to 30 kg/m^2, an overweight patient shows a BMI greater than or equal to 25 kg/m^2 and lower than 30 kg/m^2, and a normal patient has a BMI lower than 25 kg/m^2.[19] No other anthropometric measures have been adopted due to patient's postoperative limitation to get out from the bed, considering that the ICU did not have bed scales for all patients. To calculate the BMI, the formula BMI = weight (kg) ÷ height (m^2) has been used.[19] The weight and height at admission were assumed to calculate the BMI.

The findings were double-entered into the software *Microsoft Excel*, in order to minimize typing errors. Descriptive analysis (summary and dispersion measures) and inferential analysis were performed according to data distribution by means of the software *Statistical Package for the Social Sciences* (SPSS), version 23. For analysis between categorical variables, Fisher's exact test has been adopted or the chi-square test, where appropriate. Analysis of continuous variables was performed by using the Mann-Whitney test. The result with $p < 0.05$ was considered significant.

This study has been approved by the Research Ethics Committee of the Cardiology Institute of the Brazilian Federal District (ICDF), in complying with Resolution CNS No. 466/2012, under the Brazilian Certificate of Submission for Ethical Assessment (CAAE) No. 44999215.9.0000.0026.

RESULTS

Most of the 57 patients were elderly (63±9 years), predominantly women (54.4%) and overweight (27.1±4.2 kg/m^2). Among patients, arterial hypertension (75.4%) and dyslipidemia (61.4%) prevailed as comorbidities. Almost all patients were discharged from the ICU and the hospital. However, most of them (78.9%) evolved with renal dysfunction, according to the KDIGO classification (Table 1).

Table 1. Patients's clinical characteristics (n = 57) within the postoperative period of myocardial revascularization. Brasília (DF), 2017.

Characteristics	N (%)	Mean ± SD[1]
Women	31 (54.4)	
Age (years)	-	63±9
BMI[2] (kg/m^2)	-	27.1±4.2
Comorbidities		
Diabetes mellitus	24 (42.1)	-
Arterial hypertension	43 (75.4)	-
Alcoholism	2 (3.5)	-
Smoking	19 (33.3)	-
Dyslipidemia	35 (61.4)	-
Chronic kidney disease	3 (5.3)	-
HF[3] FC[4] II/III	1 (1.8)	-
HF[3] FC[4] I	6 (10.5)	-
Hospital outcome		
Discharge	54 (94.7)	-
Death	1 (1.8)	-
ICU outcome		
Discharge	56 (98.2)	-
Death	1 (1.8)	-
Renal dysfunction	45 (78.9)	-

[1]SD = standard deviation; [2] BMI = body mass index; [3] HF = heart failure; [4] FC = functional class.

Out of the patients followed up, almost half (42.1%) were overweight and almost 1/4 (22.8%) were obese (Table 2).

Table 2. Distribution of patients (n = 57) within the postoperative period of myocardial revascularization according to the body mass index. Brasília (DF), 2017.

Characteristics	N (%)	Median (25%-75%)	Mean ± SD[1]
Normal (BMI[2] < 25)	19 (33.3)	22.9 (22.3-23.8)	22.9 ± 1.2
Overweight (BMI ≥ 25 and BMI < 30)	24 (42.1)	27.2 (26.1-28.3)	27.2 ± 1.3
Obese (BMI ≥ 30)	13 (22.8)	32.0 (30.5-35.3)	33.1 ± 3.2

[1] SD = standard deviation; [2] BMI = body mass index.

Table 3 highlights that more than half of the obese patients evolved significantly with kidney injury or renal failure (p = 0.01) in relation to non-obese patients. Arterial hypertension similarly affected both the non-obese (72.1%) and the obese group (84.6%). On the other hand, diabetes mellitus predominated in obese patients (61.5%). There was no significant difference in length of ICU stay between the 2 groups (p = 0.1) (Table 3).

Table 3. Relation between clinical characteristics and patients' obesity status within the postoperative period of myocardial revascularization. Brasília (DF), 2017.

Characteristics	Non-obese[1] (n = 43)	Obese[2] (n = 13)	P value[3]
Women	25 (58.1)	6 (46.2)	0.4
Comorbidities			
Diabetes mellitus	16 (37.7)	8 (61.5)	0.1
Arterial hypertension	31 (72.1)	11 (84.6)	0.5
Alcoholism	1 (2.3)	1 (7.7)	0.4
Smoking	12 (27.9)	7 (53.8)	0.1
Dyslipidemia	27 (62.8)	7 (53.8)	0.6
Chronic Kidney Disease	2 (4.7)	0 (0.0)	0.9
Heart failure - HF I[4]	4 (9.3)	2 (15.4)	0.6
Renal dysfunction	34 (79.1)	10 (76.9)	0.6
Injury or failure	7 (16.3)	7 (53.8)	0.01
ICU time (days)	3.0 (2.0-5.0)	2.0 (2.0-3.0)	0.1

[1] Non-obese = patient with BMI < 30 kg/m^2; [2] Obese = BMI ≥ 30 kg/m^2; [3] Chi-square test, Fisher's test, Mann-Whitney test; [4] FC I = functional class I.

Surgery time was higher in obese patients (p = 0.01). The APACHE II severity index was higher among those who were overweight when compared to obese patients (p = 0.01), as well as the occurrence of intraoperative complications, resulting in higher mortality in the overweight group (p = 0.02) (Table 4).

Table 4. Association between surgery characteristics and patients' obesity status within the postoperative period of myocardial revascularization. Brasília (DF), 2017.

Characteristics	Overweight[1] (n = 24)	Obesity[2] (n = 13)	P value[3]
LIM_AD[4]	24 (100.0%)	12 (92.3%)	0.4
Number of bridges < 3	2 (8.3%)	1 (7.7%)	0.9
Surgery time[a] (minutes)	280 (240–300)	320 (300–360)	0.01
ECC[5]	23 (95.8%)	13 (100.0%)	0.9
ECC time[5] (minutes)	88 (70-105)	120 (75-130)	0.08
Anoxia	23 (95.8%)	13 (100.0%)	0.9
Anoxia time (minutes)	80 (60-98)	90 (62-106)	0.4
Intraoperative complications	4 (16.7%)	1 (7.7%)	0.6
MV time[6] (minutes)	830 (715-1080)	880 (630-985)	0.6
NIV[7]	10 (45.5%)	3 (27.3%)	0.5
APACHE II	12 (11-16)	10 (6-12)	0.01
Mortality	14.6 (12.9-21.8)	11.3 (6.7-15.6)	0.02

[1] Overweight = BMI ≥ 25 and < 30 kg/m^2; [2] obesity = BMI ≥ 30 kg/m^2; [3] Mann-Whitney test and Fisher's test; [4] LIM_AD = left myocardial bridge internal mammary artery to anterior descending; [5] ECC = extracorporeal circulation; [6] MV = mechanical ventilation; [7] NIV = non-invasive ventilation.

Overall, according to the urine output criterion, 10 obese patients (77%) evolved predominantly with stages 1 and 2 (risk for kidney injury and kidney injury). No patient evolved with stage 3 (renal failure). Overweight patients were also predominantly at risk for kidney injury (stage 1), but 1 (4.2%) evolved with renal failure, a stage of greater severity according to the KDIGO classification (Table 5).

Table 5. Distribution of overweight and obese patients at renal dysfunction stages according to the KDIGO classification. Brasília (DF), 2017.

Stage	Overweight (n = 24)		Obesity (n = 13)	
	Serum creatinine criterion*	Urine output criterion	Serum creatinine criterion*	Urine output criterion
Stage 1	11 (45.8%)	10 (41.7%)	5 (38.5%)	5 (38.5%)
Stage 2	0 (0.0%)	4 (16.7%)	2 (15.4%)	5 (38.5%)
Stage 3	1 (4.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

*Some patients evolved with normal renal function.

DISCUSSION

Obesity is a complex condition, with severe social and psychological dimensions that affect virtually all age groups and socioeconomic groups.[20] Overweight and obese patients are significantly younger than those with normal weight, unlike in this study, whose profile consists of the elderly.[21]

It is noteworthy that, in individuals affected by obesity, compensatory kidney hyperfiltration occurs to meet the high metabolic demands imposed by increase in body weight, consequently an elevation in intraglomerular pressure is observed, which can lead to kidney damage and increase the risk for renal dysfunction.[22]

Obese patients usually accumulate comorbidities, therefore, in addition to being more susceptible to AKI, they show more severe complications than non-obese patients.[23-4] This finding was also identified in our study.

Obesity in patients undergoing cardiac surgery has not been shown to be associated with perioperative mortality.[25] Above all, scientific evidence describes that obesity exhibits an inverse or null relation to mortality.[26-7] In this study, such a relation was null, i.e. it virtually did not exist when considering that almost all (94.7%) patients evolved to hospital discharge. However, recent studies clearly show that patients with obesity and critical illness benefit from greater survival when treated at the ICU[23], a fact that may be associated with the high percentage of hospital discharge evidenced in this study.

Despite the adverse effects of obesity, studies have stressed the existence of an 'obesity paradox,' according to which normal-weight patients with established coronary artery disease are associated with a worse clinical prognosis than obese patients.[21,28]

In this strand, obesity, depending on the severity of disease, may accumulate two roles. It is generally accepted that adipose tissue can work as an energy reservoir and obese patients, because of their high energy storage, are able to better tolerate stressful and harmful conditions than those who are not obese. On the other hand, the role of fat does not seem to play a significant role in low-severity patients, considering that the energy consumption process and the muscle mass loss are reduced.[23]

The need for a better understanding of the risk factors associated with the development of AKI is key, it is especially highlighted that recognizing obesity as a problem may guide clinical management strategies both within the preoperative and postoperative periods.[29]

It is known that the pathogenesis of AKI is multifactorial, thus a prolonged extracorporeal circulation (ECC) time represents a risk factor for renal dysfunction in obese patients.[30] In this study, ECC time was longer in an obese individual, in despite of this, we highlight that overweight patients, in addition to need an ECC time greater than 60 minutes, were mostly diabetic and dyslipidemic, grounding the results in relation to the frequency of kidney injury and renal failure identified in this study.

The surgery and ECC times were higher in obese patients. ECC, common in cardiac surgeries, is responsible for triggering an inflammatory response, whose intensity may vary according to the procedure time. A previous study describes the existence of a correlation between surgery time and ECC time due to developing renal dysfunction within the postoperative period. Thus, a predisposition of obese patients to evolve with AKI within the postoperative period has been noticed.[5] On the opposite way, the APACHE II index and mortality were higher in overweight patients when compared to those who were obese.

Studies describe that if increased BMI is one of the main risk factors for complications, the worse the prognosis determining the increased mortality in the population as a whole.[1,6] Although scientific evidence indicates that within the postoperative period obesity is assessed as a survival benefit when compared to normal BMI or low weight.[1,6]

Evolving with a lower degree of renal impairment characterized the obese patients when compared to those overweight in this study, evidencing a probable benefit of obesity. A situation grounded in the paradox described above.

Understanding the relation between obesity and AKI favors and helps health professionals in their prevention and, consequently, improves the population's quality of life, reducing costs to the health system. Identifying the modifiable risk factors, such as obesity, guides and supports actions and interventions so that they are actually effective.[4]

The limitations of this study refer to the small sample size, development at a single ICU, and restriction of anthropometric measurements due to the impossibility of getting the patient out from the bed, along with the insufficient number of beds at the ICU. On the other hand, the predisposition of patients with a BMI equal to or greater than 25 kg/m^2 to evolve with AKI has been identified. However, such a finding stimulates a greater awareness of the possibility of postoperative AKI in obese individuals and induces both the evaluation and deployment of timely interventions when fluctuations in urine production or serum creatinine levels occur.

CONCLUSION

There was a relation between obesity and the occurrence of AKI. Thus, increasing the understanding of this relation may guide health professionals, including nurses, in the preparation of preventive measures and, consequently, improve the population's quality of life, besides reducing costs to the health system.

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