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Acute kidney injury in pancreatic surgery; association with urine output and intraoperative fluid administration

Or Goren [a, b], Amalia Levy [b], Anat Cattan [a], Guy Lahat [c], Idit Matot [a, *]

[a] Division of Anesthesiology, Pain, and Intensive Care, Tel Aviv Medical Center, Tel Aviv University Sackler School of Medicine, Tel Aviv, Israel
[b] Departments of Public Health, Faculty of Health Sciences, Ben-Gurion University of the Negev, Beer Sheva, Israel
[c] Department of Surgery, Tel Aviv Medical Center, Tel Aviv University Sackler School of Medicine, Tel Aviv, Israel

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ABSTRACT

Background: Acute kidney injury (AKI) is a devastating postoperative complication. Intraoperative urine output is assumed to reflect patient's intravascular volume and kidney function. We thus evaluated the incidence of postoperative AKI and its association with intraoperative urine output and the volume of fluid administered.
Methods: A retrospective study on 153 consecutive patients admitted to Tel Aviv Medical Center for pancreatic surgery.
Results: The incidence of AKI in patients undergoing pancreatic surgery was 9.8%. Oliguria was not a predictor of AKI. There was no association between the amount of fluids administered and AKI. Pulmonary disease is an independent predictor of AKI. AKI is an independent predictor of mortality.
Conclusions: AKI is common in patients undergoing pancreas surgeries and is associated with high mortality. Neither urine output, nor the volume of fluids administered correlate with postoperative AKI. Low diuresis is therefore not a sole marker for fluid administration.

1. Introduction

Acute kidney injury (AKI) is not an uncommon complication of the postoperative period.[1,2] A study of 569 patients undergoing liver resection reported perioperative AKI as high as 15%.[3] A study conducted on a large national data base found AKI incidence in exploratory laparotomy to be 3.5%.[4]

Postoperative AKI prolongs hospital stay and is associated with considerable morbidity and mortality.[1] Up to 7% of the patients with postoperative AKI will need renal replacement therapy, in which case, mortality can be as high as 60–80%.[1]

AKI is both identified and defined by a rise in serum creatinine and/or a reduction in urinary output. Recently, AKI was classified according to the RIFLE criteria with further modification - in the AKIN criteria[5] and in the KDIGO criteria.[6]

One of the common assumptions of physicians is that a low intraoperative urine output reflects, in part, the patient's intravascular volume and renal function and as such may be a marker or even the reason for postoperative AKI. Indeed, in a survey conducted among members of the American Society of Anesthesiologists and European Society of Anaesthesiology, the second most common indication for volume expansion, and the second most common method of assessing fluid responsiveness in the intraoperative period was urine output.[7] The operative patient, nevertheless, presents with unique problems in identifying AKI. Recent studies suggested that urine output may be reduced significantly during surgery and may be unrelated to renal function.[8,9] Moreover, excessive volume administration, which is a “reflective” response at times to a low urine output, may cause postoperative morbidity.[10-12]

Pancreatic surgeries are lengthy major intra-abdominal procedures involving considerable fluid shifts and postoperative morbidity. We hypothesized that intraoperative urine output during major abdominal surgery (pancreatic surgery) does not predict postoperative AKI. Thus, the main objective of the present study was to analyze the relationship between intraoperative urine output, intraoperative fluid administration and postoperative AKI. The Secondary objective of the study was to identify risk factors for AKI.

* Corresponding author. 6 Weitzman Street, Tel Aviv, 6423906, Israel.
E-mail address: iditm@tlvmc.gov.il (I. Matot).

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2. Materials and methods

With Institutional Review Board approval by the Tel Aviv Medical Center Institutional Review Board (IRB no. 0161-12-TLV) we retrospectively studied a cohort of prospectively collected data on 153 consecutive patients undergoing primary, open, non-emergent pancreatic surgery in the Tel Aviv Medical Center between 01.01.2007 and 12.31.2011.

2.1. Patients

Demographic data were obtained from patients' admission and discharge files. For intraoperative data we used a prospectively collected database. Inclusion criteria were patients ≥18 years old that were admitted for an elective open pancreatic surgery. Exclusion criteria were surgeries that included an intervention in the urethra, ureters or kidneys, laparoscopic surgeries or surgeries with a cross clamp proximal to the renal arteries. Patients that were exposed to contrast dye in the preceding 7 days before the surgery or in the following 2 days after the surgery and patients already on renal replacement therapy were also excluded.

The only colloid solution used during the study period was Hydroxyethyl Starch (HES). The surgeries were all conducted by a qualified and experienced surgical team. Anesthesia was managed according to the anesthesiologist's preference.

2.2. Outcomes

2.2.1. Primary outcomes

a. The incidence of AKI: AKI was defined according to AKIN criteria[6] (Stage 1- Increased serum creatinine *1.5–2 or serum creatinine increase =>0.3 mg/dL or urine output<0.5 ml/kg/hr for more than 6 h. Stage 2 Increased serum creatinine *2–3 or urine output<0.5 ml/kg/hr for more than 12 h. Stage 3 Increased serum creatinine *3 or more or serum creatinine =>4 mg/dL when serum creatinine is in acute rise (=>0.5 mg/dL) or urine output<0.3 ml/kg/hr for more than 24 h or anuria for 12 h) Baseline (preoperative) creatinine levels were compared with the highest creatinine level in the first postoperative 48 h. An increased serum creatinine *1.5 or a rise of 0.3 mg/dL in the peak postoperative creatinine level was considered a kidney in risk (stage 1) of AKI according to the AKIN criteria.[6]

b. Urine output, incidence of oliguria and volume of fluid administration as possible predictors of AKI. Oliguria was defined as a urine output of less than 0.5 ml/kg/hr and was calculated from the intraoperative data.

2.2.2. Secondary outcome

2.2.2.1. Perioperative risk factors of AKI

Chronic kidney disease was defined as a preoperative creatinine level >1.1 mg/dL for females and >1.3 mg/dL for males. Renal disease was defined as any kidney disease recorded in the patient medical records. Preoperative anemia was defined as the preoperative hemoglobin (Hb) level <12 g/dL for females and <13 g/dL for males.

2.3. Statistical analysis

Power calculations: Our power calculations were based on the prevalence of AKI and the mean urine output in our research population. Our sample size enables us to find a difference of 1.5 ml/kg/hr of urine output between the groups with a power of 80% and α of 5%.

Univariate analysis: Continuous variables were compared using the students' T test for unpaired samples when normal deviation was assumed. When the data were not assumed to deviate normally the non-parametric Wilcoxon test was used. Continuous data are presented as average ± standard deviation. Categorical data were analyzed using the chi square test. The Fisher exact test was used when more than 20% of the expected observations were less than 5 or any expected observation was less than 2. Categorical data are presented as a number of cases and percent.

Multivariate analysis: Logistic regression was used to determine independent predictors of AKI. Meaningful clinical and demographic variables [American Society of Anesthesiologists Score 3–4 (ASA 3–4), age and gender] and all variables significant at the p of 0.1 level of significance in the univariate analysis were included as potential explanatory variables in the regression modeling. All the data included in the model were analyzed to identify interactions between the variables.

Statistical analysis was performed using IBM Statistics SPSS 22.

3. Results

3.1. Demographic and surgical data (Tables 1 and 2)

This is a retrospective evaluation of prospectively collected data from patients undergoing pancreatic surgeries in the Tel Aviv medical center over a 5 year period between 2007 and 2011. Our original database consisted of 280 patients. Thirty seven patients were excluded for failure to retrieve the patients' files. Twenty four patients were excluded for reasons related to the surgery (6 surgeries involved the kidney, 12 were laparoscopic surgeries, 4 surgeries were converted to palliative procedures and 2 surgeries involved several abdominal organs). One patient was excluded due to exposure to contrast dye. Sixty five patients were excluded due to lack of information on perioperative creatinine, intraoperative fluid administration, intraoperative urine output, length of surgery or weight. A total of 153 patients were included in the final analysis. These were mostly ASA 2–3 patients (91%), mean (SD) age of 63.8 (11.7) years and similar numbers of males and females. The most prevalent preoperative diseases were hypertension, dyslipidemia and diabetes mellitus. Many of the patients presented with anemia (n = 67, 43.8%). The patients' demographics and co-morbidities, with and without postoperative AKI, are presented in Table 1.

The majority of the operations were due to malignancies. The most common procedure was pancreaticoduodenectomy (72%), followed by distal pancreatectomy (20%), total pancreatectomy (5%) and other smaller pancreatic procedures such as enucleation or sphincterotomy (3%). The average (SD) duration of the surgeries was 6 (2) hours and the length of hospital stay was 19.2 (17.8) days. The mean ± SD amount of crystalloids and colloids administered during surgeries were 12.8 ± 5.5 ml/kg/hr and 12.8 ± 15.9 ml/kg, respectively. The perioperative variables of the patients, with and without postoperative AKI, are presented in Table 2. Noticeably, there were no statistically significant differences between patients who developed AKI and those who did not in the duration of intraoperative mean arterial pressure ≤55 mmHg or in the intraoperative use of cathecholamines/vasopressors.

3.2. Outcomes

Primary (Table 2): The incidence of post-operative AKI was 9.8% (n = 15).

There was no significant difference in intraoperative urine output between patients with or without AKI (P 0.3 95% CI