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Original article

Predicting morbidity after robotic partial nephrectomy: The effect of tumor, environment, and patient-related factors

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Abstract

Purpose: To investigate the effect of tumor and nontumor related parameters on perioperative outcomes of robotic partial nephrectomy (RPN).

Patients and methods: Patients who underwent RPN for a localized renal tumor at 2 institutions between June 2010 and November 2016 were reviewed. RENAL and Mayo adhesive probability (MAP) scores were calculated and information on comorbid conditions including ASA score, performance status, Charlson's comorbidity index (CCI), and history of cardiovascular disease was collected. Correlations between each variable and warm ischemia time, estimated blood loss (EBL), operative time, change in estimated glomerular filtration rate, and length of hospital stay were assessed. Logistic regression analyses were performed to identify the best predictors of overall complications, major complications, risk of conversion, and Trifecta achievement.

Results: A total of 500 patients were included. RENAL score was found to have a statistically significant ($P < 0.05$) correlation with warm ischemia time, EBL, and change in estimated glomerular filtration rate. MAP score showed significant association ($P < 0.05$) with operative time and EBL. CCI had a significant correlation ($P < 0.05$) with length of hospital stay and postoperative complications. In multivariable analyses, MAP score as a continuous variable (OR = 7.66; $P < 0.001$) and MAP risk group stratification (OR = 3.29; $P = 0.005$) were independent predictors of the risk of conversion. Major complications were significantly associated with the cardiovascular disease in both univariable (OR = 2.35; $P = 0.01$) and multivariable analysis (OR = 4.52, $P = 0.01$). Finally, the MAP score as a continuous variable was an independent factor of Trifecta achievement (OR = 0.56; $P = 0.04$).

Conclusion: Patients related factors were the most important determinants of postoperative complications after RPN. RENAL and MAP scores had some influence on intraoperative parameters.

Keywords: Complication; Partial nephrectomy; Robotic surgical procedures; Nephrometry scores; Comorbidities

1. Introduction

Partial nephrectomy (PN) is the standard treatment of localized renal tumors [1,2]. During the past few years, robotic assistance has increasingly been adopted [3] as it provides similar oncological outcomes with lower morbidity compared to the open approach [4]. Nonetheless, robotic partial nephrectomy (RPN) remains a challenging procedure with a high risk of surgical complications that potentially could explain its underuse [5].

Awareness of clinical factors associated with postoperative complications can help the surgeon plan the procedure, improve perioperative outcomes, as well as counsel

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patients appropriately on treatment related morbidity. Factors related to tumor complexity can be evaluated by the RENAL score [6]. In this regard, data remains conflicting with some studies suggesting that the RENAL score was associated with worse perioperative outcomes [7,8], while others failed to confirm these findings [9]. Other potential factors are linked to the tumor environment. Adherent perinephric fat (APF) has been reported to be associated with increased operative time (OT), blood loss, and risk of conversion from robotic to open PN or even total nephrectomy [10,11]. Additionally, groups have highlighted that the imaging based Mayo adhesive probability (MAP) score [12] can predict the presence of APF. Finally, recent data suggested that medical comorbidities could be associated with increased complications after PN [13].

With this multitude of potential contributing factors, delineating the variables most associated with RPN remains a challenge. Therefore, the purpose of this study was to investigate the effect of tumor and nontumor related parameters on perioperative outcomes in a large cohort of patients undergoing RPN.

2. Patients and methods

2.1. Study design

After institutional review board approval, a retrospective review of 2 prospectively maintained databases was performed to identify all patients who underwent planned RPN for a localized renal tumor between June 2010 and November 2016. There was an initial population of 570 patients. Patients who had multiples masses on the same kidney ($n = 7$) and those in whom imaging data were unavailable ($n = 63$) were excluded. All procedures were performed using the da Vinci surgical system through a transperitoneal approach.

2.2. Covariates

Demographics and tumor characteristics were collected in an electronic database. Demographics included age, sex, American Society of Anesthesiologists (ASA) classification, body mass index (BMI), Charlson's comorbidity index (CCI), history of cardiovascular disease (CAD), Eastern Cooperative Oncology Group (ECOG) score, estimated glomerular filtration rate (eGFR) calculated using the abbreviated Modification of Diet in Renal Disease (MDRD) formula, anticoagulant/antiplatelet treatments, previous abdominal surgery, indication for nephron-sparing surgery (categorized as imperative [i.e., single kidney or preoperative eGFR <60 ml/min], or elective [no imperative criteria]). Tumor characteristics included tumor size, tumor position, stage, and histological subtype. APF was defined as inflammatory adipose tissue adhering to the renal parenchyma that made kidney dissection difficult and resulted into bleeding or kidney decapsulation [11]. The presence of APF was systematically mentioned by surgeons in their operative report. CAD was defined as a history of angina, myocardial infarction, congestive heart failure, or peripheral vascular disease [14]. Previous abdominal surgery was defined as any open or laparoscopic procedure that entered the peritoneal cavity.

2.3. Radiological parameters

Preoperative CT scans or MRI were retrospectively reviewed to calculate RENAL and MAP scores. At both institutions, 2 independent physicians blinded to all clinical information (Z.K, C.R. and N.K., H.R.) reviewed imaging studies and calculated RENAL and MAP scores. In case of discordance, the opinion of a third reader was requested (K.B. and J.R.).

The RENAL score was calculated as described by Kutikov [6]. Tumors were stratified as low (score 4–6), intermediate (score 7–9), and high (score 10–12) complexity. The MAP score was calculated as described by Davidiuk [12] by measuring posterior renal fat thickness and the importance of perinephric fat stranding and was categorized as low (range: 0–3) or high (range: 4–5).

2.4. Perioperative outcomes

The following variables were collected: total operative (docking and console) time (OT), warm ischemia time (WIT), estimated blood loss (EBL), conversion to radical nephrectomy or open surgery, overall complication rate, major complication rate, positive surgical margins, length of hospital stay, readmission rate, and absolute change in eGFR. Postoperative complications were graded using the Clavien-Dindo classification [15]. Major complications were defined as a Clavien score of 3 or higher. All outcomes were recorded within 30 days after the procedure. Achievement of Trifecta [16] was defined as the combination of a WIT $<$ 25 minutes, negative surgical margins, and no perioperative complications.

2.5. Statistical analysis

Descriptive statistics were reported as median and interquartile range (IQR) for continuous variables, frequencies and percentages for categorical variables. Spearman rank correlation coefficients were determined between continuously coded scores and quantitative perioperative outcomes. Logistic regression was used to perform univariable and multivariable analyses to identify predictors of conversion to radical nephrectomy or open surgery, overall complications, major complications, and Trifecta achievement. For each outcome, we generated 2 different models, including RENAL and MAP scores considered as continuous variables (model 1) and RENAL and MAP scores stratified by groups (model 2). Multivariable models