Assessment of Patient-Related Operative Complexity During Partial Nephrectomy: Comparison of Two Tailored Methods for Measurement of Posterior Perinephric Fat Thickness on Preoperative CT

Na Yeon Han¹, Deuk Jae Sung¹, Min Ju Kim¹, Beom Jin Park¹, Ki Choon Sim¹ and Seok Ho Kang²

¹Department of Radiology, Anam Hospital, Korea University, Seoul, Republic of Korea
²Departments of Urology, Anam Hospital, Korea University, Seoul, Republic of Korea

*Corresponding author: Department of Radiology, Anam Hospital, Korea University, 73 Goryeodae-ro Seongbuk-gu, Seoul, Republic of Korea. Email: urorad@korea.ac.kr

Received 2020 June 28; Revised 2020 September 30; Accepted 2021 February 20.

Abstract

Background: Adherent perinephric fat affects operative complexity during partial nephrectomy (PN) and it could be predicted using computed tomography (CT) based on the Mayo adhesive probability (MAP) score.

Objectives: To investigate reproducible measurement methods of perinephric fat with comparison of two tailored methods for measurement of posterior perinephric fat thickness (PPFT) on preoperative CT and examine the association between the methods and operative complexity in PN.

Patients and Methods: This cross-sectional study included 72 consecutive patients who underwent robotic-assisted or open PN. The data on operative time, ischemia time, and pathologic results were obtained. Two radiologists independently assessed PPFT based on the MAP system in the first session, and subsequently by using two tailored methods in the second session and scored for perinephric fat stranding. The nephrometry scoring system was used for stratifying the complexity of renal masses. Multiple linear regression was used to evaluate the determinants of operative time and ischemia time.

Results: For measurement of PPFT, intraclass correlation coefficients between the reviewers using two detailed methods showed no statistical difference (P = 0.173) but were significantly higher than the coefficients scored in the first session (P < 0.001). Nephrometry score was a determinant of ischemia time (P < 0.001 and 0.001 for two reviewers) and PPFT was identified as a determinant of operative time (P ≤ 0.023 in all the analysis using two different methods for both the reviewers) in robotic-assisted PN. Nephrometry score was identified as a determinant of ischemia time in open PN as per one of the reviewers (P = 0.006).

Conclusion: The tailored methods presented herein were more reproducible than the MAP score and demonstrated that increased PPFT was related to longer operative time in robotic-assisted, and not in open PN.

Keywords: Nephrectomy, Multidetector Computed Tomography, Kidney Neoplasm, Intra-abdominal Fat

1. Background

Renal cell carcinoma (RCC) is the third most common cancer of the genitourinary system and represents approximately 3% to 5% of all adult malignancies (1). Currently, RCCs are frequently diagnosed at clinical T1a because of the widespread use of abdominal imaging (2). Furthermore, with the advancements in laparoscopic and robot-assisted techniques, minimally invasive nephron-sparing surgery has been increasingly adopted for management of small renal masses. Compared to total nephrectomy, in case of nephron-sparing surgery, it is important to identify preoperative anatomic features of the kidney, renal vessels, and the tumor because of complexity of the technique. Therefore, the role of cross-sectional imaging in the treatment of small renal masses has diversified from detection and staging of tumors to prediction of operative complexity before surgery. Traditionally, operative complexity evaluated with the major emphasis on tumor-related anatomic factors, including tumor size, location, centrality, tumor depthness into the parenchyma, and nearness of the tumor to the sinus, which are described using the RENAL (radius, exophytic/endophytic properties, nearness of tumor to the collecting system or sinus in millimeters, and anterior/posterior location relative to polar lines) nephrometry scoring system (3). Since the first description of the RENAL nephrometry scoring system in 2009, more than 10 nephrometry scoring systems have been published (4). However, studies have shown that even during operation of masses under similar conditions of tumors, various dif-
Objectives

The purpose of this study was to investigate reproducible measurement methods of perinephric fat with comparison of two tailored methods for the measurement of PPFT on preoperative CT and examine the association between the methods and operative complexity in PN.

3. Patients and Methods

3.1. Patient Selection

This cross-sectional study received approval from the institutional review board, and the requirement for informed consent was waived. From September 2012 through August 2016, 75 patients (58 men and 17 women) underwent PN performed by a single experienced surgeon (BLINDED) at BLINDED Hospital. Among 75 patients, three patients were excluded due to the absence of pathologic result (n = 1) and lack of record for ischemia time (n = 2). Finally, 72 patients (56 men and 16 women; age range, 32 - 89 years) were enrolled in the present study. Of the 72 patients, 44 underwent robotic-assisted surgery and 28 underwent open surgery. Data on operative time and ischemia time, pathologic results, and BMI were obtained from medical chart reviews. Operative time and ischemia time were used as reference standards to reflect operative complexity.

3.2. CT Technique

Preoperative CT scans acquired within 1 month of surgery were available for all included patients. All CT examinations were performed on one of three scanners: a 64-channel CT scanner (Brilliance 64; Philips Medical Systems, Cleveland, OH [detector collimation, 64 × 0.625 mm; reconstruction, 3- or 5-mm slice thickness; 120 kV; and 120 - 280 mAs]) and two 128-channel CT scanners (SOMATOM Definition ASI; Siemens, Erlangen, Germany [detector collimation, 6430.6 mm using z-flying focal-spot technology; reconstruction, 3- or 5-mm slice thickness; 100 kV; and 100 - 350 mAs] and SOMATOM Definition Flash; Siemens [detector collimation, 12830.6 mm; reconstruction, 3- or 5-mm slice thickness; and 100-kVp tube voltage using online dose modulation] with CARE Dose4D; Siemens). CT images were acquired after administration of 2 mL/kg body weight of non-ionic iodinated contrast material (iobitridol [Xenetix 300; Guerbet, Villepinte, France] or iopamidol [Pamirey 300; Dongkook Pharmaceutical, Seoul, South Korea]) by using a power injector at a rate of 2.5 - 3.0 mL/s.

3.3. Image Analysis

In the MAP score (8), measurement of posterior perinephric fat thickness (PPFT) was described as “drawing a direct line posteriorly from the renal capsule to the posterior abdominal wall”. In a previous study, PPFT was defined as the shortest distance that was measured by drawing a line towards the posterior abdominal wall at the level of the renal vein”. Therefore, in the first review session, the two blinded reviewers, with 7 and 23 years of experience of abdominal CT interpretation, measured PPFT according to the PPFT\textsubscript{Mayo} method without training. After completing the first review session, one study coordinator (BLINDED with 11 years of experience in abdominal CT interpretation) provided training to the two reviewers on the tailored methods for evaluating PPFT to overcome the ambiguity of the MAP scoring system. Thereafter, in the second review session, which was performed more than 2 weeks after the first session, PPFT was measured using the two different methods. On the basis of the findings of a recent study showing maximal association between the MAP score and posterolateral perinephric fat thickness (11), PPFT\textsubscript{posterolateral} was defined as the longest distance measured by drawing a line towards the posterolateral direction from the capsule to the transverse abdominis muscle, intercostal muscle, or their tendons, perpendicular to the capsule. PPFT\textsubscript{posterior abdominal wall} was defined as the shortest distance that was measured by drawing a line
from the capsule to the quadratus lumborum muscle, perpendicular to the capsule (Figure 1). PPFT was measured at the level where the ipsilateral renal vein was largest. Perinephric fat stranding was defined as linear or curvilinear soft-tissue attenuation without a vascular connection and with distribution in the perinephric space. Gerota’s fascia was used as a generic term to describe both anterior and posterior pararenal fasciae. On CT images, the following three-point scale was defined to score severity: 0 = no stranding; 1 = focal stranding; and 2 = diffuse or multifocal stranding or presence of Gerota’s fascia thickening (Figure 2). The RENAL nephrometry scoring system, which refers to the five elements that constitute the operative complexity of the tumor, was used for stratifying the complexity of renal masses as previously used and described in the literature (12). Two reviewers independently assessed PPFT, the perinephric stranding score, and the RENAL nephrometry score. Reviewers magnified the selected image and evaluated using image archiving and communication system (INFINITT PACS, version 3.0; INFINITT Healthcare, Seoul, Korea).

3.4. Statistical Analysis

We performed statistical analyses by using IBM SPSS Statistics for Windows/Macintosh, version 20.0 (IBM Corp., Armonk, NY). Interobserver agreement between the two reviewers for PPFT, the perinephric fat stranding score, and the RENAL nephrometry score was analyzed using kappa statistics or the intraclass correlation coefficient (ICC). The strength of agreement was defined based on the kappa or ICC value as poor (< 0.20), fair (0.21 - 0.40), moderate (0.41 - 0.60), substantial (0.61 - 0.80), or excellent (0.81 - 1.00). The ICCs were compared between the groups using Fisher’s z-test (13). The measured data, baseline characteristics, and ischemia time and operative time were compared between the groups using the χ2 test, Fisher’s exact test, and Mann-Whitney U-test. A multiple linear regression analysis with stepwise variable selection method was used to evaluate the effect of age, sex, body mass index, pathology, laterality, PPFT, perinephric stranding and nephrometry score on operative time and ischemia time in open and robotic-assisted PN. A P value < 0.05 was considered statistically significant.

4. Results

Demographic data of the patients who underwent open or robotic-assisted PN are listed in Table 1. Ischemia time and operative time were significantly shorter in open PN (mean, 19.1 ± 6.9 min and 3.1 ± 0.6 h, respectively) than in robotic-assisted PN (mean, 25.3 ± 7.4 min and 3.5 ± 0.7 h, respectively) (P < 0.001 and 0.034, respectively). Patients who underwent open PN were significantly older than those who underwent robotic-assisted PN. Measured data including PPFT, perinephric fat stranding score, RENAL nephrometry score, sex, BMI, pathologic results, and tumor laterality showed no significant differences between the two groups.

Interobserver agreement between the two reviewers for PPFT was excellent (ICC, 0.854; 95% confidence interval [CI]: 0.767 - 0.910) when measured using PPFT⁳costal; excellent (ICC, 0.965; 95% [CI]: 0.944 - 0.978) when measured using PPFT⁳lumborum; and excellent (ICC, 0.980; 95% [CI]: 0.970 - 0.988) when measured using PPFT⁳lumborum. The ICCs between the two reviewers when using PPFT⁳costal and PPFT⁳lumborum showed no statistical differences (P = 0.173, Fisher’s z-test); however, the ICCs when using the two tailored methods, including PPFT⁳costal and PPFT⁳lumborum, were significantly higher than that when using PPFT⁳lumborum (P < 0.001 and P < 0.001, respectively). Interobserver agreement between the two reviewers was also excellent (ICC, 0.921; 95% [CI]: 0.877 - 0.950) for the RENAL nephrometry score and substantial (kappa value, 0.698; 95% [CI]: 0.671 - 0.775) for the perinephric fat stranding score.

The results of the multiple linear regression are shown in Table 2. It was observed that the RENAL nephrometry score was a determinant of ischemia time (P < 0.001 or 0.001) and PPFT was a determinant of operative time (P = 0.009 ~ 0.023) in robotic-assisted PN for both the reviewers. In open PN, the RENAL nephrometry score and BMI were identified as the determinants of ischemia time (P = 0.002 ~ 0.014). However, analysis of operative time showed different results between the two reviewers; the RENAL nephrometry score was observed as a determinant in reviewer 1 (P = 0.033) and sex was observed as a determinant in reviewer 2 (P = 0.049).

5. Discussion

Traditional nephrometry scoring systems, such as the RENAL score and the preoperative aspects and dimensions used for an anatomical (PADUA) score, could be used to predict the complexity of PN by focusing on renal morphometry (3, 14). However, these nephrometry scoring systems do not take into account the patient-specific factors, which lead to complications in the technical aspects of PN. The BMI is the simplest estimate of obesity but does not specify a patient’s relative distribution of abdominal wall fat and fat surrounding the internal organs. Several previous studies have demonstrated that perinephric fat is a stronger determinant of operative complexity than is the BMI in patients undergoing robotic-assisted PN (15, 16). Because
Two different methods for measuring posterior perinephric fat thickness (PPFT) in two different patients (A, B). PPFT\textsubscript{costal}: Yellow arrows; PPFT\textsubscript{lumborum}: Blue arrows.

robotic-assisted PN is mostly performed via the transperitoneal approach, subcutaneous fat no longer acts as an obstacle after the robotic instrument enters the abdominal cavity, while the amount of perinephric fat is crucial in dissecting the renal hilum and exposing the tumors. In particular, because the increased thickness of posterior perinephric fat was shown to be associated with higher operative complexity (8, 15), PPFT was included in the MAP score to assess operative complexity by analyzing CT images. Based on the authors’ experience, however, the method of measuring PPFT proposed in the MAP scoring system appears as ambiguous and less reproducible because of the bumpy surface of the posterior boundary of perinephric fat, which is made up of the quadratus lumborum muscle and abdominal wall muscles including the transverse abdominis muscle, intercostal muscle, or their tendons. In addition, it is hypothesized that the reproducibility of the measurement may further be reduced because of various angles between the wall and the kidney. To overcome this problem, our study described a more detailed measurement method. As the quadratus lumborum muscle was relatively flat or convex and narrow at the back of the kidney, it was considered as a suitable and reproducible target to measure the shortest distance perpendicular to the renal capsule for measuring PPFT\textsubscript{lumborum}. On the contrary, since the inner margin of the abdominal wall, consisting of the transverse abdominis muscles, intercostal muscles, or their tendons, was concave and widely located at the posterior and posterolateral aspects of the kidney, it was considered as an accurate target to measure the longest distance for measuring PPFT\textsubscript{costal}. Our study has shown that when PPFT was measured using these detailed methods, the strength of agreement between the two reviewers was significantly higher than that measured using the method presented in the MAP scoring system. For these two tailored methods, the strength of agreement between the two reviewers was excellent without any statistical difference between the ICCs for measuring PPFT\textsubscript{lumborum} and PPFT\textsubscript{costal}. Consequently, both methods devised in this study were observed to be suitable for measuring PPFT.

Investigation of the determinants predicting operative complexity using PPFT\textsubscript{lumborum} and PPFT\textsubscript{costal} in robotic-assisted PN revealed that PPFT was associated with operative time and RENAL nephrometry score was associated with ischemia time. These results are in agreement with the ones published in previous studies (9, 17, 18). On the contrary, in open PN, only the nephrometry score was identified as a relevant factor predicting ischemia time for both
Figure 2. Three-point scale for evaluating the degree of perinephric fat stranding. A-B, No stranding (score 0); C-D, Focal stranding (score 1); E-F, Diffuse or multifocal stranding or presence of Gerota’s fascia thickening (score 2).

the reviewers and operative time for one of the reviewers. For another reviewer, neither PPFT nor the RENAL nephrometry score was related to the two parameters reflecting operative complexity. It is known from previous studies that the nephrometry score in open PN is related to various perioperative outcomes (19), but the effect of perinephric fat-related factors as per the different methods of PN has not been studied. The difference in the effect of PPFT on operative complexity in two different surgical methods can be explained by the difference in surgical approach. In
Table 1. Demographic and Measured Data of Patients Who Underwent Open or Robotic-Assisted Partial Nephrectomy

|                      | Open partial nephrectomy | Robotic-assisted partial nephrectomy | P value |
|----------------------|--------------------------|--------------------------------------|---------|
| **PFFT<sub>costal</sub>, mm** |                          |                                      |         |
| Reviewer 1           | 13.57 ± 7.74             | 14.28 ± 8.91                        | 0.777   |
| Reviewer 2           | 13.77 ± 7.55             | 14.46 ± 8.64                        | 0.725   |
| **PFFT<sub>lumborum</sub>, mm** |                      |                                      |         |
| Reviewer 1           | 6.51 ± 6.99              | 7.91 ± 7.08                         | 0.301   |
| Reviewer 2           | 7.07 ± 6.77              | 8.14 ± 7.16                         | 0.560   |

**Perinephric stranding**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 14:12:2    | 21:21:2    | 0.854   |
|                      | 12:14:2    | 19:23:2    | 0.893   |

**RENAL nephrometry score**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 6.36 ± 1.254 | 6.48 ± 1.455 | 0.941   |
|                      | 6.39 ± 1.197 | 6.55 ± 1.547 | 0.845   |

**Ischemia time, min**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 19.07 ± 6.89567 | 25.3089 ± 7.42679 | < 0.001 |

**Operative time, h**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 3.14 ± 0.63 | 3.47 ± 0.69 | 0.034   |

**Age, y**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 61.00 ± 12.88 | 52.57 ± 11.30 | 0.008   |

**Sex (male: female)**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 20:8       | 36:8       | 0.386   |

**BMI**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 25.80 ± 3.40 | 25.28 ± 3.06 | 0.368   |

**Pathology (malignant: benign)**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 26:2       | 39:5       | 0.698   |

**Laterality (right: left)**

|                      | Reviewer 1 | Reviewer 2 | P value |
|----------------------|------------|------------|---------|
|                      | 16:2       | 24:20      | 1.000   |

Abbreviations: BMI, body mass index; PFFT, posterior perinephric fat thickness; PFFT<sub>costal</sub>, the longest distance measured by drawing a line towards the posterolateral direction from the capsule to the transverse abdominis muscle, intercostal muscle, or their tendons, perpendicular to the capsule; PFFT<sub>lumborum</sub>, the shortest distance that was measured by drawing a line from the capsule to the quadratus lumborum muscle, perpendicular to the capsule; RENAL, radius, exophytic/endophytic properties, nearness of tumor to the collecting system or sinuses in millimeters, and anterior/posterior location relative to polar lines.

Values are expressed as mean ± SD.

Table 2. Results of Multiple Linear Regression Analyses of Ischemia Time or Operative Time Using Stepwise Variable Selection Method

| Type of partial nephrectomy | Method for measuring PFFT | Dependent variables | Reviewer 1 | Reviewer 2 | Statistically significant variables | B | SE | Standardized Regression coefficient | P value | Statistically significant variables | B | SE | Standardized Regression coefficient | P value |
|----------------------------|----------------------------|---------------------|------------|------------|------------------------------------|---|----|------------------------------------|---------|------------------------------------|---|----|------------------------------------|---------|
| Robotic-assisted           | PFFT<sub>costal</sub>      | Ischemia time       | Nephrometry | 2.418      | 0.935     | 0.472                             | 0.001 | Nephrometry | 2.429 | 0.839 | 0.479                             | 0.001   |
|                           | PFFT<sub>lumborum</sub>    | Ischemia time       | Nephrometry | 2.418      | 0.935     | 0.472                             | 0.001 | Nephrometry | 2.429 | 0.839 | 0.479                             | 0.001   |
|                           | PFFT<sub>costal</sub>      | Operative time      | PFFT       | 0.027      | 0.011     | 0.343                             | 0.023 | PFFT       | 0.031 | 0.011 | 0.39                             | 0.009   |
|                           | PFFT<sub>lumborum</sub>    | Operative time      | PFFT       | 0.016      | 0.004     | 0.372                             | 0.013 | PFFT       | 0.017 | 0.004 | 0.39                             | 0.009   |
| Open                      | PFFT<sub>costal</sub>      | Ischemia time       | Nephrometry | 2.534      | 0.475     | 0.479                             | 0.006 | Nephrometry | 3.075 | 0.872 | 0.534                             | 0.002   |
|                           | PFFT<sub>lumborum</sub>    | Ischemia time       | BMI        | 0.854      | 0.501     | 0.423                             | 0.014 | BMI        | 0.847 | 0.510 | 0.408                             | 0.002   |
|                           | PFFT<sub>costal</sub>      | Operative time      | BMI        | 0.414      | 0.210     | 0.621                             | 0.004 | BMI        | 0.567 | 0.104 | 0.408                             | 0.002   |
|                           | PFFT<sub>lumborum</sub>    | Operative time      | BMI        | 0.191      | 0.099     | 0.404                             | 0.013 | BMI        | 0.666 | 0.246 | 0.382                             | 0.009   |

Abbreviations: B, un-standardized regression coefficient; BMI, body mass index; CI, confidence interval; PFFT, posterior perinephric fat thickness; PFFT<sub>costal</sub>, the longest distance measured by drawing a line towards the posterolateral direction from the capsule to the transverse abdominis muscle, intercostal muscle, or their tendons, perpendicular to the capsule; PFFT<sub>lumborum</sub>, the shortest distance that was measured by drawing a line from the capsule to the quadratus lumborum muscle, perpendicular to the capsule; SE, standard error.

Covariates included in a multiple linear regression model were age, sex, body mass index, pathology, laterality, perinephric stranding, posterior perinephric fat thickness and nephrometry score, and only the covariates which showed statistical significance are written in a table. The dependent variables in each model were the continuous variables, ischemia time and operative time.

robotic-assisted surgery, a small incision is made, and dissection is performed to expose the tumor and hilum using robotic instruments, which leads to technical difficulties in patients with large amounts of perinephric fat tissue.
However, in open surgery, fat could be dissected in a relatively free manner from the surrounding tissues through wide exposure, which does not seem to affect operative time.

Perinephric fat stranding has been reported as the determinant for predicting operative complexity in the MAP score along with PPFT (8), and the underlying pathophysiology of perinephric “sticky fat” has been thought to be inflammation, desmoplasia, idiopathic fibrosis, or autoimmune response (20). However, from a radiological perspective, the cause of perinephric fat stranding varies from acute to chronic, with a wide spectrum of conditions including acute ureteral obstruction, pyelonephritis, bladder outlet obstruction, postoperative change, acute pancreatitis, and metastasis (21-24). Moreover, in a histopathologic comparison of patients with or without APF, Dariane et al. (17) demonstrated no significant difference in inflammatory infiltration or fibrosis in the perinephric tissue but only significantly larger adipocytes in patients with APF and concluded that the histology of adhesive perinephric fat was unclear. In the present study, the degree of perinephric fat stranding was not associated with operative or ischemia time, thereby revealing its irrelevance in predicting operative complexity. Therefore, it may not be appropriate to just predict operative complexity on the basis of imaging finding of perinephric infiltration because it could not represent “sticky fat”. Another problem in assessing perinephric fat stranding is its low reproducibility (24), and our study also showed substantial agreement between the two reviewers for perinephric fat stranding.

The development of a scoring system is important to reduce the arbitrariness in determining the surgical approach; however, it is unwise to make the scoring system more complicated by including all relevant factors, because only intuitive and simple scoring systems can be used widely in the urology community (25). Therefore, it is important to consider a proper scoring system by creating a balance between the two values, i.e., more detailed but complex versus simple but less predictive. Sharma et al. showed that the RENAL nephrometry score was associated with the surgical approach, which was intuitively chosen by an experienced surgeon, but the MAP score exhibited no correlation with decision-making between open and robotic-assisted PN (26). In our opinion, in addition to the RENAL nephrometry score, measured PPFT could be reasonably used for predicting operative complexity.

The current study has several limitations. First, it represents a single-institutional, single-surgeon experience, and the number of patients who underwent open PN was small. Second, the presence of APF was not confirmed during surgery. Third, data were collected data over a period of 4 years; it is hypothesized that the surgeon’s surgical skill, which affects ischemia time or operative time, might have improved over time.

In conclusion, the method presented in this study is more reproducible than the method using MAP score. Based on the presented method, increase in PPFT was found to be related to a longer operative time in robotic-assisted PN but not in open PN. Moreover, perinephric fat stranding had little effect on operative complexity in PN.

Footnotes

Authors’ Contributions: Study concept and design: NYH, DJS, and SHK. Analysis and interpretation of images and data: NYH, KCS, and DJS. Drafting of the manuscript: NYH. Critical revision of the manuscript for important intellectual content: MJK, KCS, and BJP. Statistical analysis: NYH and DJS.

Conflict of Interests: There is no conflict of interests.

Ethical Approval: This cross-sectional study received approval from the Institutional Review Board (code: 2014ANO340).

Funding/Support: This study was financially supported and funded by a research grant (grant number: I1702771) from Dongkook Pharmaceutical (Seoul, Korea). The authors were not employees of the company and had full control over the data and information submitted for publication.

Informed Consent: Requirement for informed consent was waived.

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2016. CA Cancer J Clin. 2016;66(1):7–30. doi: 10.3322/caac.21332. [PubMed: 26743998].
2. Pierorazio PM, Hyams ES, Mullins JK, Albad ME. Active surveillance for small renal masses. Rev Urol. 2012;14(1):3–9.
3. Joshi SS, Uzzo RG. Renal Tumor Anatomic Complexity: Clinical Implications for Urologists. Urol Clin North Am. 2017;44(2):79–87. doi: 10.1016/j.ucl.2016.12.004. [PubMed: 28449190].
4. Hou W, Yan W, Ji Z. Anatomic features involved in technical complexity of partial nephrectomy. Urology. 2015;85(1):7–13. doi: 10.1016/j.urology.2014.10.009. [PubMed: 25303959].
5. Khene ZE, Peyronnet B, Mathieu R, Fardoun T, Verhoest G, Bensalah K. Analysis of the impact of adherent perirenal fat on peri-operative outcomes of robotic partial nephrectomy. World J Urol. 2015;33(1):1801–6. doi: 10.1007/s00345-015-1504-0. [PubMed: 25696860].
6. Gong EM, Orvieto MA, Lyon MB, Lucioni A, Gerber GS, Shalhav AL. Analysis of impact of body mass index on outcomes of laparoscopic renal surgery. Urology. 2007;69(1):38–43. doi: 10.1016/j.urology.2006.09.020. [PubMed: 17270610].
7. Eaton SH, Thirumavalavan N, Katz MH, Babayan RK, Wang DS. Effect of body mass index on perioperative outcomes for laparoscopic partial nephrectomy. J Endourol. 2011;25(9):447–50. doi: 10.1089/end.2010.0664. [PubMed: 2185804].
8. Davidiuk AJ, Parker AS, Thomas CS, Leibovich BC, Castle EP, Heckman MG, et al. Mayo adhesive probability score: an accurate image-based scoring system to predict adherent perinephric fat in partial nephrectomy. Eur Urol. 2014;66(6):165-71. doi: 10.1016/j.eururo.2014.08.054. [PubMed: 25929688].

9. Davidiuk AJ, Parker AS, Thomas CS, Heckman MG, Custer K, Thiel DD. Prospective evaluation of the association of adherent perinephric fat with perioperative outcomes of robotic-assisted partial nephrectomy. Urology. 2015;85(4):836-42. doi: 10.1016/j.urolou.2014.12.017. [PubMed: 26569734].

10. Thiel DD, Davidiuk AJ, Meschia C, Serie D, Custer K, Petrou SP, et al. Mayo Adhesive Probability Score Is Associated With Localized Renal Cell Carcinoma Progression-free Survival. Urology. 2016;89:54-60. doi: 10.1016/j.urology.2015.10.014. [PubMed: 26738181].

11. Ji C, Tang S, Yang K, Xiong G, Fang D, Zhang C, et al. Analysis of Factors Influencing Mayo Adhesive Probability Score in Partial Nephrectomy. Med Sci Monit. 2017;23:5026-32. doi: 10.12659/msm.907938. [PubMed: 29266141]. [PubMed Central: PMC5747448].

12. Parsons RB, Canter D, Kurtikov A, Uzzo RG. RENAL nephrometry scoring system: the radiologist’s perspective. AJR Am J Roentgenol. 2012;199(3):W355–9. doi: 10.2214/AJR.11.8355. [PubMed: 22915426].

13. Donner A, Zou G. Testing the equality of dependent intraclass correlation coefficients. J Royal Stat Soc. 2002;3(1):367-79. doi: 10.1111/1467-9884.00324.

14. Ficarra V, Novara G, Secco S, Macchi V, Porzionato A, De Caro R, Raman JD, Reynolds C, Hannon M. An increasing proportion of perinephric fat with perioperative outcomes of robotic-assisted partial nephrectomy. World J Urol. 2013;31(5):1165-9. doi: 10.1007/s00345-012-0867-4. [PubMed: 22527672].

15. Macleod LC, Hsi RS, Gore JL, Wright JL, Harper JD. Perinephric fat thickness is an independent predictor of operative complexity during robot-assisted partial nephrectomy. J Endourol. 2014;28(5):587-91. doi: 10.1089/end.2013.0647. [PubMed: 24377722].

16. Raman JD, Reynolds C, Hannon M. An increasing proportion of perinephric fat to subcutaneous fat is associated with adverse perioperative outcomes of robotic partial nephrectomy. J Robot Surg. 2016;10(3):255-9. doi: 10.1007/s11701-016-0593-9. [PubMed: 27160676].

17. Dariane C, Le Guilhlet T, Hurel S, Audelet F, Beaugerie A, Badoaul C, et al. Prospective assessment and histological analysis of adherent perinephric fat in partial nephrectomies. Urol Oncol. 2017;35(2):39 e9-39 e17. doi: 10.1016/j.urolonc.2016.09.008. [PubMed: 28434196].