Mini Review



Preoperative Evaluation of the Renal Function Before Kidney Cancer Surgery



Tao-Nong Cai^{1,2,3}, Jiang-Li Lu^{1,2,3}, Zi-Ke Qin^{1,2,3} and Yun-Lin Ye^{1,2,3*}

¹Department of Urology, Sun Yat-sen University Cancer Center, Guangzhou, Guangdong, China; ²State Key Laboratory of Oncology in South China, Sun Yat-sen University Cancer Center, Guangzhou, Guangdong, China; ³Collaborative Innovation Center for Cancer Medicine, Guangzhou, Guangdong, China

Received: June 09, 2023 | Revised: August 06, 2023 | Accepted: August 14, 2023 | Published online: September 25, 2023

Abstract

Renal function is the basic focus of examination before kidney cancer surgery and determines the choice of surgery procedure. The prediction of renal function after surgery may also affect the surgical method, and it will certainly affect the prognosis of the patient. Herein, we provide a review of the relevant literature on partial nephrectomy (PN) and radical nephrectomy (RN) respectively, discuss methods for estimating kidney function, and compare effects. We found that the most reliable way to predict new baseline glomerular filtration rate (GFR) after PN was the quantitative estimation of the Percent of Preserved Parenchymal Mass (PPPM), while the simplest way to predict new-baseline GFR after RN was derivation from contralateral kidney, with \geq 45 mL/min/1.73 m² considered a good cutoff to evaluate the kidney function and survival outcomes. In addition, based on AI, the imaging-guided analysis would provide a feasible, simple, and reliable prediction model.

Introduction

In renal cancer surgery, kidney function is one of the most fundamental topics during preoperative counseling. When it is technically feasible, partial nephrectomy (PN) is recommended for clinical T1 renal tumors for its oncologic equivalence to radical nephrectomy (RN), while radical nephrectomy is essential when there could be one of several consequences, for example, carcinoma of kidney pelvis and complex renal tumor with normal contralateral kidney.^{1,2} In this clinical dilemma, effective kidney function prediction is of significant importance.

In several large-population studies, kidney function was reported to be associated with non-cancer mortality and cancer-specific survival. In their meta-analysis, Simon et al. (2012) suggested that partial nephrectomy conferred a lower risk of chronic kidney disease (HR 0.39, p < .001) and a survival advantage (HR 0.81, p < 0.001).³ Antonelli and his colleagues also demonstrated that

cancer-specific mortality was associated with estimated glomerular filtration rates (eGFR) when they were below the cutoffs, and renal function should be preserved to improve cancer-related survival.⁴ On the other hand, some recent investigations revealed that kidney function was not associated with cancer-specific mortality. Moreover, Gershman et al. (2018) revealed that radical nephrectomy was associated with an increased risk of chronic kidney disease but not with cancer-specific mortality or all-cause mortality.5 And in the unique prospective research (EORTC 30904), PN achieved better kidney function and was not associated with better survival outcomes.^{6,7} Campbell and his team found that patients with a new baseline glomerular filtration rate (NBGFR) ≥45 mL/minute/1.73 m² had a better survival outcome and an increased NBGFR above this cutoff was not correlated with a better survival outcome.8 Furthermore, their recent research confirmed that kidney function was not associated with cancer-specific survival, and an increased preoperative eGFR was associated with reduced all-cause mortality.9

However, the significance of kidney function for survival is still in debate but whatever the outcome, effective kidney function prediction remains important during clinical management of kidney tumors. If a higher GFR is required, PN should be performed if feasible. If the contralateral kidney had enough GFR, PN or RN would not be a difficult decision for a complicated renal mass. In this review, we will analyze the most popular methods of kidney function prediction and compare their effects. In PN cases, parenchymal volume preservation is the most important part of renal function preservation, while in RN cases, the compensation of the contralateral kidney is critical to newbaseline kidney function. Thus, we divided the review into two parts; the first one is focused on PN and the other on RN.

© 2023 The Author(s). This article has been published under the terms of Creative Commons Attribution-Noncommercial 4.0 International License (CC BY-NC 4.0), which permits noncommercial unrestricted use, distribution, and reproduction in any medium, provided that the following statement is provided. "This article has been published in Cancer Screening and Prevention at https://doi.org/10.14218/CSP.2023.00025 and can also be viewed on the Journal's website

at https://www.xiahepublishing.com/journal/csp".

Keywords: Renal function; Partial nephrectomy (PN); Radical nephrectomy (RN); Glomerular filtration rate (GFR)

Abbreviations: AI, artificial intelligence; C-index, centrality index; CSA, contact surface area; DAP, diameter-axial-polar; GFR, glomerular filtration rate; NBGFR, new baseline glomerular filtration rate; PADUA, preoperative aspects and dimensions used for an anatomical classification; PN, partial nephrectomy; PPPM, percent of preserved parenchymal mass; QE, quantitative estimation; RN, radical nephrectomy.

^{*}Correspondence to: Yun-Lin Ye, Department of Urology, Sun Yat-sen University Cancer Center, Guangzhou, Guangdong 510060, China. ORCID: https://orcid.org/ 0000-0001-5424-7066. Tel: +86-15920398260, E-mail: yeyunl@sysucc.org.cn

How to cite this article: Cai TN, Lu JL, Qin ZK, Ye YL. Preoperative Evaluation of the Renal Function Before Kidney Cancer Surgery. Cancer Screen Prev 2023; 2(3):173-176. doi: 10.14218/CSP.2023.00025.

		• ·		
Research	No.	Endpoints	Results	Variables
Shum <i>et al</i> , 2017 ¹⁸	461	eGFRs	Coefficients of determination: 0.70	age, race, sex, BMI, diabetes, HTN, IHD, stroke; preop. creatinine, preop. ipsilateral KV, SK; size
Bhindi <i>et al,</i> 2019 ¹⁹	1920	eGFRs	Marginal R ² : 0.62	age, DB, HTN preop. eGFR, PNU, SK
Martini <i>et al,</i> 2018 ²⁰	999	25% eGFR decrease	C index: 0.75	age, CCI, sex, preop eGFR RENAL score
Bertolo <i>et al,</i> 2019 ²¹	1897	NB-CKD stage	AUC: 0.79	age, sex, BMI, preop. CKD stage; RENAL score
Mari <i>et al</i> , 2022 ²²	981	25% eGFR decrease	AUC: 0.82	age, sex, DB, CCI, peripheral vascular disease, preop. eGFR, PADUA score

AUC, area under curve; BMI, body mass index; CCI, charlson comorbidity index; C-index, centrality index; DB, diabetes; eGFR, estimated glomerular filtration rate; HTN, hypertension; IHD, ischemic heart disease; KV, kidney volume; NB-CKD, new baseline chronic kidney disease; PADUA, preoperative aspects and dimensions used for an anatomical classification; PNU, proteinuria; preop., preoperative; SK, solitary kidney.

Kidney function prediction for patients undergoing PN

In PN cases, if the ischemia time is limited (less than 30 min), parenchymal volume preservation is at the center of kidney function prediction. Until now, the Percent of Preserved Parenchymal Mass (PPPM) has been the most reliable and reasonable method of predicting new-baseline kidney function. However, once AI based on a 3D reconstruction system can calculate the volume of parenchymal loss, it will provide a feasible, simple, and objective method and Dr. Campbell from Cleveland Clinic has already presented his initial work on this topic.¹⁰ If the ischemia time is extended, kidney function recovery must be taken into consideration. As reported, every minute above 30 min would affect recovery from ischemia.¹¹ The compensation of the contralateral kidney has proven limited and not significant. A new method combining PPPM and an extended ischemia time should be developed and evaluated for efficacy above that of PPPM alone. Based on parenchymal volume preservation, several methods have been developed to predict postoperative kidney function or new-baseline kidney function.

It has been reported that PPPM is strongly associated with postoperative kidney function.¹² Surgeon assessment of volume preservation before PN (subjective estimation of PPPM) and calculating parenchymal volume based on imaging (quantitative estimation PPPM) are reasonable estimates of functional renal volume preservation. Also, nephrometry scores such as RENAL-(R)adius, (E) xophytic/endophytic, (N)earness to collecting system/sinus, (A) nterior/posterior, and (L)ocation relative to polar lines-nephrometry, preoperative aspects and dimensions used for an anatomical classification (PADUA), centrality index (C-index), diameter-axial-polar (DAP), and contact surface area (CSA), which are scoring systems designed to quantify tumor complexity, are reported to be associated with kidney function preservation.¹³⁻¹⁷ As listed in Table S1, most scoring systems were modestly correlated with ipsilateral kidney function and only the DAP score had a favorable correlation to postoperative kidney function, but it was not validated in another cohort. Even for quantitative estimation (QE) PPPM, the correlation with ipsilateral kidney function was significant and modest (r = 0.46) although the correlation between QE PPPM and postoperative global renal function was strong (r=0.91).12 These results might reveal that the minor variation of ipsilateral kidney function had a limited impact on the total kidney function of patients with normal contralateral kidneys.

Besides the above methods, some prediction models have been developed based on regression analysis to predict new-baseline kidney function (listed in Table 1).^{18–22} In 2019, Mayo Clinic developed a new model to predict kidney function for patients undergoing renal surgery.²³ For PN cases, age, solitary kidney, hyper-

tension, preoperative eGFR, preoperative proteinuria, and surgical approach were associated with worse long-term renal function. The marginal and conditional R² GLMM values of this model in predicting long-term renal function were 0.62 and 0.85. An external validation from Belgium demonstrated that early postoperative renal failure following PN and RN showed an AUC of 0.816 and 0.825 using the Mayo model and developed a new model to predict long-term renal function; the marginal and conditional R² GLMM values were 0.591 and 0.855 for the PN cases, and 0.363 and 0.849 for the RN cases, respectively.24 However, both of these models were similar and suffered from being too complicated to perform in clinical practice. Aguilar Palacios D et al. from Cleveland Clinic also developed a simple model to predict new-baseline renal function. The accuracy of predicting renal function was 83% and 82% in internal and external validation. The AUC values to differentiate whether new-baseline renal function \geq 45 mL/minute/1.73 m² were 0.89 and 0.91 in internal and external validation.²⁵ As we know, the new-baseline renal function \geq 45 mL/minute/1.73 m² was a critical cutoff in evaluating whether the renal function would affect overall survival and the prediction model seemed strong in evaluating perioperative kidney function.

Kidney function prediction for patients undergoing RN

Different from PN cases, all parenchymal masses in the ipsilateral kidney were removed with tumor. The prediction of new-baseline kidney function focused on the compensation of the contralateral kidney. In addition, some methods have been developed based on regression analysis to predict new-baseline kidney function.

Both Mayo Clinic and Cleveland Clinic have developed models to predict renal function after radical nephrectomy. In the Mayo Clinic's model, older age, diabetes, lower preoperative eGFR, worse preoperative proteinuria, and smaller tumor size were associated with worse new-baseline renal function. The calculation method, however, is somewhat complicated.²³ Moreover, they found that time from surgery interacted with a number of factors, which meant some comorbidity could affect kidney function in long-term follow-up and may not be derived from renal surgery.

In Cleveland Clinic's model, the method of prediction of newbaseline renal function is simple. Based on split renal function from parenchymal volume analysis, the model focuses on the compensation of the contralateral kidney, which would be simple and consistent. They found that age (-0.85, p < 0.01), global preoperative estimated glomerular filtration rate (-0.28, p < 0.01), and split renal function of the removed kidney (0.61, p < 0.01) were

Table 2.	Kidney	function	prediction	for	patients	underwent	ΡN	or	RN
----------	--------	----------	------------	-----	----------	-----------	----	----	----

Surgical procedure	Theoretical bases	Predictive methods
PN	Ischemia time less than 30 min	The volume of parenchymal loss calculated by AI
	Ischemia time more than 30 min	Subjective estimation of PPPM and quantitative estimation of PPPM
		RENAL, PADUA, C-index, DAP, CSA
		Mayo model
		Belgium model
		Cleveland model
RN	Compensation of contralateral kidney	Mayo model
		Cleveland model

AI, artificial intelligence; C-index, centrality index; CSA, contact surface area; PADUA, preoperative aspects and dimensions used for an anatomical classification; PN, partial nephrectomy; PPPM, percent of preserved parenchymal mass; RN, radical nephrectomy.

independent predictors of renal function compensation. Based on these findings, they developed an equation to calculate the NB-GFR: 35 + preoperative glomerular filtration rate ($\times 0.65$) - 18 - age ($\times 0.25$) + 3 (if tumor size >7 cm) - 2 (if diabetes).²⁶ They then developed a new simple method of predicting new baseline eGFR: 1.24 × preoperative eGFR of the contralateral kidney. They compared this simple method with five other models that were not based on split renal function. The results revealed that the new equation based on split renal function and compensation offered a better prediction than the five other models, including their own models and those of Mayo.^{27,28}

The compensation of the contralateral kidney in RN cases was associated with the primary renal function of each kidney and comorbidity, which was critical to recovery from ischemia and longterm postoperative kidney function in PN cases. The renal function of each kidney was easy to estimate, while the degree of each related comorbidity was difficult to calculate making it difficult to build a feasible and reliable model. Thus, a multicenter, large-populated prospective clinical trial should be performed to collect detailed comorbidity data and evaluate its effect on compensation and recovery from ischemia and long-term kidney function (Table 2).

Prospective

Until now, the simplest method of predicting new-baseline GFR after RN was derivation from the contralateral kidney, and the most reliable method after PN was a quantitative estimation of PPPM. In addition, some measures have also been reported as predictors of postoperative renal function, such as preoperative MR volumetry and perioperative blood transfusion.^{29,30} These metrics, although valid, have yet to be tested in terms of reliability in clinical use. At present, 3D reconstruction systems and AI are being widely applied in this field. We believe that with the help of different forecasting models, 3D reconstruction systems, and AI calculation, prediction will become quicker, more consistent, and simpler in the hopefully not-too-distant future.

Conclusions

To build a favorable model of predicting renal function was not simple. In some models, preoperative factors and postoperative factors were mixed, and the prediction value was confusing.³¹ In the meantime, the primary endpoint was also important for model building. In the early period, most research focused on calculating

an exact value for kidney function, which was a continuous variable, and increased the complexity of prediction. In recent years, we have found that greater than 45 mL/minute/ 1.73 m^2 is a good cutoff to evaluate kidney function and survival outcomes; calculating whether kidney function is >45 mL/minute/ 1.73 m^2 seems a much better method. Moreover, based on AI, imaging-guided analysis would make a feasible, simple, and reliable prediction model.

Supporting information

Supplementary material for this article is available at https://doi. org/10.14218/CSP.2023.00025.

 Table S1. The renal function predicting values based on scoring systems of tumor complexity.

Acknowledgments

None.

Funding

None.

Conflict of interest

One of the authors, Dr. Yun-Lin Ye has been an editorial board member of *Cancer Screening and Prevention* since March 2022. The authors have no other conflict of interests.

Author contributions

Contributed to study concept and design (TNC and YLY), acquisition of the data (JLL and YLY), assay performance and data analysis (TNC, JLL, ZKQ, and YLY), drafting of the manuscript (TNC and YLY), critical revision of the manuscript (YLY and ZKQ), supervision (YLY and ZKQ).

References

 Zhao W, Ding Y, Chen D, Xuan Y, Chen Z, Zhao X, et al. Comparison of Transperitoneal and Retroperitoneal Robotic Partial Nephrectomy for Patients with Completely Lower Pole Renal Tumors. J Clin Med

Cancer Screen Prev

Cai T.N. et al: Preoperative evaluation of renal function

2023;12(2):722. doi:10.3390/jcm12020722, PMID:36675653.

- [2] Liu J, Tian C, Zhang Z, Zhou G, Shi B, Zhao H, et al. Correlation between preoperatively predicted and postoperatively observed renal function using an imaging-based approach: A retrospective cohort study. Oncol Lett 2020;20(1):501–508. doi:10.3892/ol.2020.11584, PMID:32565975.
- [3] Kim SP, Thompson RH, Boorjian SA, Weight CJ, Han LC, Murad MH, et al. Comparative effectiveness for survival and renal function of partial and radical nephrectomy for localized renal tumors: a systematic review and meta-analysis. J Urol 2012;188(1):51–57. doi:10.1016/j. juro.2012.03.006, PMID:22591957.
- [4] Antonelli A, Minervini A, Sandri M, Bertini R, Bertolo R, Carini M, et al. Below Safety Limits, Every Unit of Glomerular Filtration Rate Counts: Assessing the Relationship Between Renal Function and Cancer-specific Mortality in Renal Cell Carcinoma. Eur Urol 2018;74(5):661–667. doi:10.1016/j.eururo.2018.07.029, PMID:30104082.
- [5] Gershman B, Thompson RH, Boorjian SA, Lohse CM, Costello BA, Cheville JC, et al. Radical Versus Partial Nephrectomy for cT1 Renal Cell Carcinoma. Eur Urol 2018;74(6):825–832. doi:10.1016/j. eururo.2018.08.028, PMID:30262341.
- [6] Van Poppel H, Da Pozzo L, Albrecht W, Matveev V, Bono A, Borkowski A, et al. A prospective, randomised EORTC intergroup phase 3 study comparing the oncologic outcome of elective nephron-sparing surgery and radical nephrectomy for low-stage renal cell carcinoma. Eur Urol 2011;59(4):543–552. doi:10.1016/j.eururo.2010.12.013, PMID: 21186077.
- [7] Scosyrev E, Messing EM, Sylvester R, Campbell S, Van Poppel H. Renal function after nephron-sparing surgery versus radical nephrectomy: results from EORTC randomized trial 30904. Eur Urol 2014;65(2):372– 377. doi:10.1016/j.eururo.2013.06.044, PMID:23850254.
- [8] Suk-Ouichai C, Tanaka H, Wang Y, Wu J, Ye Y, Demirjian S, et al. Renal Cancer Surgery in Patients without Preexisting Chronic Kidney Disease-Is There a Survival Benefit for Partial Nephrectomy? J Urol 2019;201(6):1088–1096. doi:10.1097/JU.00000000000000000, PMID:30694940.
- [9] Palacios DA, Zabor EC, Munoz-Lopez C, Roversi G, Mahmood F, Abramczyk E, et al. Does Reduced Renal Function Predispose to Cancer-specific Mortality from Renal Cell Carcinoma? Eur Urol 2021;79(6):774– 780. doi:10.1016/j.eururo.2021.02.035, PMID:33678521.
- [10] Rathi N, Attawettayanon W, Yasuda Y, Lewis K, Roversi G, Shah S, et al. Point of care parenchymal volume analyses to estimate split renal function and predict functional outcomes after radical nephrectomy. Sci Rep 2023;13(1):6225. doi:10.1038/s41598-023-33236-6, PMID:37069196.
- [11] Dagenais J, Maurice MJ, Mouracade P, Kara O, Nelson RJ, Malkoc E, et al. The Synergistic Influence of Ischemic Time and Surgical Precision on Acute Kidney Injury After Robotic Partial Nephrectomy. Urology 2017;107:132–137. doi:10.1016/j.urology.2017.03.002, PMID:283 15787.
- [12] Tanaka H, Wang Y, Suk-Ouichai C, Palacios DA, Caraballo ER, Ye Y, et al. Can We Predict Functional Outcomes after Partial Nephrectomy? J Urol 2019;201(4):693–701. doi:10.1016/j.juro.2018.09.055, PMID:30291914.
- [13] Simmons MN, Hillyer SP, Lee BH, Fergany AF, Kaouk J, Campbell SC. Nephrometry score is associated with volume loss and functional recovery after partial nephrectomy. J Urol 2012;188(1):39–44. doi:10.1016/j.juro.2012.02.2574, PMID:22578726.
- [14] Ficarra V, Novara G, Secco S, Macchi V, Porzionato A, De Caro R, et al. Preoperative aspects and dimensions used for an anatomical (PADUA) classification of renal tumours in patients who are candidates for nephron-sparing surgery. Eur Urol 2009;56(5):786–793. doi:10.1016/j.eururo.2009.07.040, PMID:19665284.
- [15] Simmons MN, Ching CB, Samplaski MK, Park CH, Gill IS. Kidney tumor location measurement using the Cindex method. J Urol 2010;183(5):1708– 1713. doi:10.1016/j.juro.2010.01.005, PMID:20299047.
- [16] Simmons MN, Hillyer SP, Lee BH, Fergany AF, Kaouk J, Campbell SC. Diameter-axial-polar nephrometry: integration and optimization of R.E.N.A.L. and centrality index scoring systems. J Urol 2012;188(2):384–

390. doi:10.1016/j.juro.2012.03.123, PMID:22698624.

- [17] Hsieh PF, Wang YD, Huang CP, Wu HC, Yang CR, Chen GH, et al. A Mathematical Method to Calculate Tumor Contact Surface Area: An Effective Parameter to Predict Renal Function after Partial Nephrectomy. J Urol 2016;196(1):33–40. doi:10.1016/j.juro.2016.01.092, PMID:26820552.
- [18] Shum CF, Bahler CD, Cary C, Masterson TA, Boris RS, Gardner TA, et al. Preoperative Nomograms for Predicting Renal Function at 1 Year After Partial Nephrectomy. J Endourol 2017;31(7):711–718. doi:10.1089/end.2017.0184, PMID:28443676.
- [19] Bhindi B, Lohse CM, Schulte PJ, Mason RJ, Cheville JC, Boorjian SA, et al. Predicting Renal Function Outcomes After Partial and Radical Nephrectomy. Eur Urol 2019;75(5):766–772. doi:10.1016/j. eururo.2018.11.021, PMID:30477983.
- [20] Martini A, Cumarasamy S, Beksac AT, Abaza R, Eun DD, Bhandari A, et al. A Nomogram to Predict Significant Estimated Glomerular Filtration Rate Reduction After Robotic Partial Nephrectomy. Eur Urol 2018;74(6):833–839. doi:10.1016/j.eururo.2018.08.037, PMID:30224195.
- [21] Bertolo R, Garisto J, Li J, Dagenais J, Kaouk J. Development and Internal Validation of a Nomogram for Predicting Renal Function after Partial Nephrectomy. Eur Urol Oncol 2019;2(1):106–109. doi:10.1016/j. euo.2018.06.015, PMID:30929839.
- [22] Mari A, Tellini R, Antonelli A, Porpiglia F, Schiavina R, Amparore D, et al. A Nomogram for the Prediction of Intermediate Significant Renal Function Loss After Robot-assisted Partial Nephrectomy for Localized Renal Tumors: A Prospective Multicenter Observational Study (RE-CORd2 Project). Eur Urol Focus 2022;8(4):980–987. doi:10.1016/j. euf.2021.09.012, PMID:34561199.
- [23] Bhindi B, Lohse CM, Schulte PJ, Mason RJ, Cheville JC, Boorjian SA, et al. Predicting Renal Function Outcomes After Partial and Radical Nephrectomy. Eur Urol 2019;75(5):766–772. doi:10.1016/j. eururo.2018.11.021, PMID:30477983.
- [24] Roussel E, Laenen A, Bhindi B, De Dobbeleer A, Stichele AV, Verbeke L, et al. Predicting short- and long-term renal function following partial and radical nephrectomy. Urol Oncol 2023;41(2):110.e1–110.e6. doi:10.1016/j.urolonc.2022.10.006, PMID:36372636.
- [25] Aguilar Palacios D, Wilson B, Ascha M, Campbell RA, Song S, De-Witt-Foy ME, et al. New Baseline Renal Function after Radical or Partial Nephrectomy: A Simple and Accurate Predictive Model. J Urol 2021;205(5):1310–1320. doi:10.1097/JU.000000000001549, PMID:33356481.
- [26] Aguilar Palacios D, Caraballo ER, Tanaka H, Wang Y, Suk-Ouichai C, Ye Y, et al. Compensatory Changes in Parenchymal Mass and Function after Radical Nephrectomy. J Urol 2020;204(1):42–49. doi:10.1097/ JU.000000000000797, PMID:32073996.
- [27] Rathi N, Yasuda Y, Palacios DA, Attawettayanon W, Li J, Bhindi B, et al. Split Renal Function Is Fundamentally Important for Predicting Functional Recovery After Radical Nephrectomy. Eur Urol Open Sci 2022;40:112–116. doi:10.1016/j.euros.2022.04.008, PMID:35572817.
- [28] Rathi N, Palacios DA, Abramczyk E, Tanaka H, Ye Y, Li J, et al. Predicting GFR after radical nephrectomy: the importance of split renal function. World J Urol 2022;40(4):1011–1018. doi:10.1007/s00345-021-03918-9, PMID:35022828.
- [29] Favorito LA. Editorial Comment: Role of preoperative MR volumetry in patients with renal cell carcinoma for prediction of postoperative renal function after radical nephrectomy and nephron sparing surgery. Int Braz J Urol 2020;46(2):242–243. doi:10.1590/S1677-5538. IBJU.2019.0217.1, PMID:32022513.
- [30] Mühlbauer J, de Gilde J, Mueller-Steinhardt M, Porubsky S, Walach M, Nuhn P, et al. Perioperative Blood Transfusion Is a Predictor of Acute and Chronic Renal Function Deterioration after Partial and Radical Nephrectomy for Renal Cell Carcinoma. Urol Int 2020;104(9-10):775–780. doi:10.1159/000509206, PMID:32721964.
- [31] Jin D, Luo Y, Zhu H, Li Y, Huang Z, Zhang Y, et al. Development and validation of an integrated nomogram to predict personalized new baseline functional outcomes after partial nephrectomy. Transl Androl Urol 2022;11(1):9–19. doi:10.21037/tau-21-952, PMID:35242637.