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Predictive Factors for Acute Kidney Injury and Long-term Renal Function Loss After Partial Nephrectomy: A Prospective Single-Center Study

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Running Headline: Factors for postoperative renal function.

Disclaimers of Potential Conflicts of Interest

The authors declare no potential conflict of interest.

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Author Contributions

H. Wang had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Abstract

Objectives:

To find factors related to postoperative acute kidney injury (AKI) and long-term significant renal function (RF) loss after partial nephrectomy (PN) in Chinese population.

Methods:

The main outcome was significant RF loss during the last follow-up, which was defined as >25% decrease in estimated glomerular filtration rate (eGFR).

Results:

A total of 416 patients were included with median age as 57 (IQR 49.8-65.0) yr with body mass index (BMI) as 24.2 (IQR 22.0-26.5) kg/m^2 and preoperative eGFR as 90.5 (IQR 79.8-101) ml/min. Summarily, 259 (62.3%) patients were male, 54 (13%) had diabetes, 180 (43.3%) hypertension and 80 (19.2%) hyperuricemia. Median (IQR) tumor diameter was 3.1 (2.4-4.1) cm. All patients underwent PN, in which 135 (32.5%) by open PN approach, 109 (26.2%) by laparoscopic PN and 172 (41.3%) by robot-assisted PN. RF was followed up for 16.88 (10.15-36.37) months, where 58 (13.9%) patients suffered significant RF loss. Multivariable analysis showed age (p=0.0039), BMI (p=0.0049), diabetes (p=0.0351), OT > 110 min (p=0.0034), diameter classification by Diameter-Axial-Polar (DAP) score (diameter 2.4cm - 4.4 cm, p=0.0225; diameter > 4.4 cm, p=0.0207), postoperative AKI (p<0.001) to be predictors of RF loss with AUC as 0.850.

Conclusions:

We prospectively found predictive factors of short and long-term significant RF loss in all operative methods and constructed a clinical nomogram for long-term Chinese patients RF loss.

Introduction

Since introduction of partial nephrectomy (PN), it has become the most preferred choice for localized T1 and part of T2 renal lesions if technically feasible with the necessity of sufficient parenchymal volume to preserve for better renal function (RF) protection, especially in those with solitary kidney, bilateral tumors and kidney dysfunction[1]. With development in technology, laparoscopic PN (LPN) and robot-assisted PN (RAPN) are prevailing worldwide with smaller incision and clearer view. However, the prognostic factors about long-term renal function loss are not yet clear. Various scoring systems has been emerging since the first introduction of Radius-Exophytic/Endophytic-Nearness-Anterior/Posterior-Location (RENAL) score in 2009[2]. But most of the nephrometry systems were designed to evaluate the difficulty of the operations instead of predict renal function outcomes. In 2021, a novel nomogram for the prediction of post-operative intermediate significant renal function loss was brought up by Andrea Mari et al in a prospective way[3]. However, the nomogram was

only applicable to RAPN and European population, so we intended to prospectively explore the different factors in Chinese population related to acute kidney injury (AKI) and long-term RF loss separately, discuss the potential explanation and create a new predictive nomogram of long-term RF loss for PN of all surgical methods including open PN (OPN), LPN and RAPN.

Materials and methods

Patients and methods

With the approval from ethics committee, prospective recruitment of patients started from August 2016 to August 2020 in Zhongshan Hospital, Shanghai (Figure 1). The inclusion criteria were listed as: 1. Renal lesion was localized without distant metastasis; 2. Renal lesion was classified as T1 and T2a stage; 3. Underwent partial nephrectomy in Urology Department regardless of operation methods; 4. With intact medical record. All the patients were followed up with repeated renal function evaluation, including creatine, estimated glomerular filtration rate (eGFR) and uric acid as well as radiological examinations every three or six months after discharge. Corresponding information were collected with informed consents. Postoperative eGFR was collected on the first day after PN operation.

All the Computed Tomography (CT) scan or Magnetic Resonance Imaging (MRI) images were independently evaluated by a urologist and a radiologist to get scores according to different scoring systems including Zhongshan Score, R.E.N.A.L. score, Preoperative Aspects and Dimensions Used for an Anatomical score (PADUA) score, Diameter-Axial-Polar (DAP) score, C-Index, Zonal Nearness-Physical-Radius-Organization (NePhRO) score and Invision Score. A third specialist would intervene by giving a final thought independently if different scores showed up. This research

has been registered and approved by Chinese Clinical Trial Registry (Registration number: ChiCTR1900025167).

Definition of factors related

The primary outcome was significant RF loss. Renal function was classified according to CKD staging system. EGFR was calculated by Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation. AKI and long-term significant renal function loss was defined as >25% drop in eGFR on the first postoperative day and the last time of follow-up compared with preoperative value according to RIFLE criteria[4]. Dyslipidemia was diagnosed if any of the following conditions was met: 1. Total cholesterol > 6.2 mmol/L; 2. Triglyceride > 2.3 mmol/L; 3. Low density lipoprotein cholesterol > 4.1mmol/L; 4. Non-high-density lipoprotein cholesterol > 4.9mmol/L. Hyperuricemia was defined as > 428 μmol/L in male and > 357 μmol/L in female.

Statistical analysis

All the statistical analysis was performed processed on the platform of R (version 3.6.3 2020-02-29). Continuous variables were reported as medians and interquartile ranges (IQRs) and categorical variables as numbers and proportions. Uni- and multivariable regression analyses were performed with ‘glmnet’ package. The predictive nomogram was generated based on multivariable logistic regression. Both the nomogram and calibration curve were generated by with ‘rms’ package. The validation of the predictive model by receiver operator characteristic (ROC) curve and area under the curve (AUC) was achieved by ‘pROC’ package. All p values are two sided and considered significant when $p < 0.05$.

Results

General information of the study.

Flowchart of our study was shown in Figure 1. Overall, 451 consecutive patients were planned to undergo partial nephrectomy. However, according to inclusion criteria, 12 of them were excluded with absence of radiological information in 10 patients and conversion to radical nephrectomy in 2 patients. During follow-up of renal function, 23 patients were lost. A total of 416 patients were included in this study. Descriptive features of all the patients were listed in Supplementary table 1. The median age was 57 (IQR 49.8-65.0) years old, with median body mass index (BMI) as 24.2 (IQR 22.0-26.5) kg/m^2, in which 259 (62.3%) patients were male, 54 (13%) patients were diagnosed as diabetes, 180 (43.3%) as hypertension and 80 (19.2%) patients as hyperuricemia. Median preoperative uric acid was 338 (IQR 273-389) μmol/L and median preoperative eGFR was 90.5 (IQR 79.8-101) ml/min. As for evaluation of tumors, median (IQR) tumor diameter was 3.1 (2.4-4.1) cm, and a median of 7.3 (6.0-8.5) points was reached in Zhongshan score, 7 (6-9) points in R.E.N.A.L score, 9 (8-10) points in PADUA score, 6 (5-7) points in DAP score, 2.3 points in C-Index, 9 (7-10) points in NePhRO score and 9 (8-11) points in Invision score. All the patients underwent PN with 50 (20-100) ml estimated blood loss (EBL), in which 135 (32.5%) operated by OPN approach, 109 (26.2%) by LPN and 172 (41.3%) by RAPN. In the OPN group, 85 (63.0%) patients underwent cold ischemic PN, also known as renal artery clamping with ice. Postoperative eGFR dropped to a median of 77 (60-93) ml/min with 100(24.0%) patients suffered from AKI. Renal function of patients was followed up for a median of 16.88 (10.15-36.37) months, in

which 58 (13.9%) patients underwent significant renal function loss, defined as >25% drop of eGFR compared with preoperative eGFR.

Univariable logistic regression analysis

The univariable analysis was applied to AKI and long-term RF loss. According to univariable analysis (Table 1), age (OR 1.04, 95% CI 1.01 to 1.07; p=0.004), male gender (OR 2.61, 95% CI 1.38 to 5.31; p=0.005), BMI (OR 1.25, 95% CI 1.14 to 1.38; p<0.001), diabetes (OR 4.03, 95% CI 2.06 to 7.69; p<0.001), hypertension (OR 2.43, 95% CI 1.38 to 4.36, 1.07; p=0.002), operative time (OR 1.01, 95% CI 1.00 to 1.02; p=0.002), preoperative eGFR (OR 0.98, 95% CI 0.964 to 0.991; p=0.0012), postoperative eGFR (OR 0.96, 95% CI 0.944 to 0.971; p<0.001), Zhongshan score (OR 1.27, 95% CI 1.11 to 1.46; p<0.001), DAP score (OR 1.39, 95% CI 1.05 to 1.87; p=0.003) and NePhRO score (OR 1.27, 95% CI 1.09 to 1.49; p=0.003) were all strong predictors of long-term renal function loss with p value less than 0.01. As for AKI, diabetes (OR 1.39, CI 0.72 to 1.29; p=0.3), hypertension (OR 1.29, CI 0.82 to 2.02; p=0.27) showed no significance, while ischemia time (OR 1.04, 95% CI 1.01 to 1.06; p=0.002), WIT > 20min in LPN and RAPN (OR 1.99, 95% CI 1.08 to 3.85; p=0.03), preoperative uric acid (OR 1.00, 95% CI 1.00 to 1.01; p<0.001), RENAL score (OR 1.51, 95% CI 1.31 to 1.76; p<0.001), PADUA score (OR 1.52, 95% CI 1.32 to 1.77; p<0.001), diameter (OR 1.69, 95% CI 1.44 to 2.00; p<0.001) and Invision score (OR 1.29, 95% CI 01.16 to 1.44; p<0.001) were significantly related. For further exploration, we selected the cutoff values for OT as 110 min and 100 min considering median OT. Univariable analysis showed that both cutoff values were significant (p<0.001) while 110 min showed higher OR.

Exploration of predictive factors based on multivariable analysis

Significant factors from univariable analysis were included in multivariable logistic regression analysis (Table 2), among which age (OR 1.05, 95% CI 1.02 to 1.09; p=0.0039), BMI (OR 1.18, 95% CI 1.06 to 1.33; p=0.0049), diabetes (OR 2.51, 95% CI 1.05 to 5.87; p=0.0351), OT > 110 min (OR 2.82, 95% CI 1.42 to 5.75; p=0.0034), diameter classification of DAP scoring system (diameter 2.4cm - 4.4 cm OR 3.73, 95% CI 1.33 to 13.45; p=0.0225; diameter > 4.4 cm OR 4.12, 95% CI 1.35 to 15.64; p=0.0207), presence of AKI (OR 5.07, 95% CI 2.56 to 10.27; p<0.001) were all significantly related to remarkable renal function loss in a long term.

Verification of the predictive model

Predictive nomogram was constructed based on aforementioned factors (Figure 2a). The predictive system derived from multivariable analysis was verified by receiver operating characteristic (ROC) curve with area under curve (AUC) as 0.850 (Figure 2b). Logistic calibration curve was generated with S:P = 0.886, Emax = 0.231 and Eavg = 0.028 (Figure 2c).

Discussion

The potential predictive factors of long-term renal function have been studied for years. The factors including radiological characteristics[5], parameters from blood and urine tests[6], and general information of patients have all been discussed but without further validation. As far as the studies have shown, PN is not so perfect in that it can preserve about 80% of the renal function in operated kidney and 90% of overall function in patients with intact two kidneys[7]. In that case, there is actual need to dig

into the predictive factors of long-term postoperative renal function loss to better educate patients undergo RN with individualized plans.

In terms of nephrometry scoring systems, according to the meta-analysis by Alessandro Veccia et al, continuous and categorical RENAL scores were independent predictors of eGFR increase and Diameter-Axial-Polar (DAP) score and Peritumoral Artery Scoring System (PASS) were independent predictors of renal function variation regardless of operative methods[8]. The conclusion reached in our study is consistent with the systemic review in that DAP score also showed significant predictive value in RF variation based on univariable analysis. Alberto Martini et al. brought up a nomogram consisting of age, gender, Charson comorbidity index (CCI), RENAL score as continuous variable, baseline eGFR, the presence of postoperative AKI in patients with normal renal function to predict significant eGFR reduction after RAPN in a retrospective way in 2018[9]. Essa M Bajalia et al prospectively validated the Martini nomogram and proved the prognostic efficiency[10]. This year, the muticenter prospective RECORd2 project raised a new nomogram predicting >25% renal function loss at 4 year after RAPN[3]. Slight differences showed up in that instead of postoperative AKI and RENAL score, this RECORd2 nomogram introduced diabetes, peripheral vascular disease, surgical indication and PADUA score. However, though with convincing scale and prospective study type, the common limitation of these researches is that the nomograms are only applicable to RAPN and suitable for most Caucasian population without extension to all kinds of PNs and all human races.

With the aim of creating a nomogram that suits all methods of operations and covers Chinese population, we constructed the nomogram consisting of age, BMI, diabetes mellitus, whether operative time exceeded 110 min, diameter levels from DAP score

and the presence of AKI. Long term was defined as at least 3 months since operation and >25% decrease in eGFR as significant RF loss.

In our study, the emphasis was put on the impacts of various scoring systems and metabolic situations of patients including uric acid, lipid and diabetes on the prognosis of long-term RF. According to the analysis, among all the scoring systems, ZS score, DAP score, C-Index score, Invision score and NePhRO score were related to long-term RF loss. Further analysis showed that DAP diameter level was significantly related to long term RF loss both in uni- and multivariable analysis. The underlying reason may be attribute to the early detection of renal lesions with the widespread health examination in Shanghai, which makes renal lesions greater than 7 cm based on RENAL and PADUA score less common. Besides, we also found that the presence of AKI could strongly indicate RF loss in the future, which was consistent with previous studies[11-13]. In clinical practice, if PN patients experienced significant decrease in eGFR, special attentions should be paid to avoidance of nephrotoxic drugs and closer follow-up of RF to avoid further deterioration of RF. According to previous studies, debates remained considering the role of shortened ischemia time in RF preservation[14]. Besides, another important conclusion was reached that no significant relationship was found between ischemia time and late RF loss. Therefore, we explored the role of ischemia time in AKI and figured that impact of ischemia time was greater on short-term drop in eGFR, which was proved before[15]. Consistent with RECORd2 project, ischemia time in our study was not significantly related to RF loss but operative time mattered. The possible explanation could attribute to systemic influences caused by operation and anesthesia that may be more important than local ischemia time in the long run, which needs further exploration and validation.

There are several limitations in our study. First of all was the follow-up time. According to the hypothesis raised up by Andrea Mari et al, the impacts of factors on future RF may vary with prolonged follow-up time[3], so studies with longer follow-up time was expected. Secondly, our study did not dig into the vascular situations which may influence RF initially and ischemic pattern[16], including the differences between zero ischemia and ischemic PN, as well as the ones between cold ischemic and warm ischemic PN due to lack of technique to cool down the operated kidney in RAPN and LPN. Additional limitations include the different surgical techniques among surgeons. Further external validation studies are expected to minimize bias.

Conclusion

We found factors that mattered to AKI and long-term RF loss and developed a peri-operative nomogram for prediction of late RF loss after PN of all operative methods in a prospective way. This nomogram could help early identify the Chinese patients that would suffer from significant RF loss in the future for timely intervention.

References

1. Ljungberg B, Bensalah K, Canfield S, et al. EAU guidelines on renal cell carcinoma: 2014 update. Eur Urol. May 2015;67(5):913-924. doi:10.1016/j.eururo.2015.01.005
2. Kutikov A, Uzzo RG. The R.E.N.A.L. nephrometry score: a comprehensive standardized system for quantitating renal tumor size, location and depth. J Urol. Sep 2009;182(3):844-853. doi:10.1016/j.juro.2009.05.035
3. Mari A, Tellini R, Antonelli A, 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 (RECORd2 Project). Eur Urol Focus. Sep 21 2021;doi:10.1016/j.euf.2021.09.012
4. Bellomo R, Ronco C, Kellum JA, et al. Acute renal failure - definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. Crit Care. Aug 2004;8(4):R204-212. doi:10.1186/cc2872
5. Cha EK, Ng CK, Jeun B, et al. Preoperative radiographic parameters predict long-term renal impairment following partial nephrectomy. World J Urol. Aug 2013;31(4):817-822. doi:10.1007/s00345-011-0694-z
6. Antonelli A, Allinovi M, Cocci A, et al. The Predictive Role of Biomarkers for the Detection of Acute Kidney Injury After Partial or Radical Nephrectomy: A Systematic Review of the Literature. Eur Urol Focus. Mar 15 2020;6(2):344-353. doi:10.1016/j.euf.2018.09.020
7. Mir MC, Ercole C, Takagi T, et al. Decline in renal function after partial nephrectomy: etiology and prevention. J Urol. Jun 2015;193(6):1889-1898. doi:10.1016/j.juro.2015.01.093
8. Veccia A, Antonelli A, Uzzo RG, et al. Predictive Value of Nephrometry Scores in Nephron-sparing Surgery: A Systematic Review and Meta-analysis. Eur Urol Focus. May 15 2020;6(3):490-504. doi:10.1016/j.euf.2019.11.004

9. Martini A, Cumarasamy S, Beksac AT, et al. A Nomogram to Predict Significant Estimated Glomerular Filtration Rate Reduction After Robotic Partial Nephrectomy. Eur Urol. Dec 2018;74(6):833-839. doi:10.1016/j.eururo.2018.08.037
10. Bajalia EM, Myers AA, Haehn DA, et al. Independent external validation of a nomogram to define risk categories for a significant decline in estimated glomerular filtration rate after robotic-assisted partial nephrectomy. Int J Urol. Jan 2021;28(1):75-79. doi:10.1111/iju.14404
11. Bernstein A, Barry E, Fram EB, et al. Does Glomerular Filtration Rate at Discharge After Partial Nephrectomy Predict Long-Term Glomerular Filtration Rate Stability? J Endourol. Jun 2019;33(6):488-491. doi:10.1089/end.2018.0869
12. Lifshitz DA, Shikanov SA, Razmaria AA, et al. Clinical and histologic predictors of renal function decline after laparoscopic partial nephrectomy. J Endourol. Sep 2011;25(9):1435-1441. doi:10.1089/end.2010.0646
13. Dawidek MT, Chan E, Boyle SL, Sener A, Luke PP. Assessing Time of Full Renal Recovery Following Minimally Invasive Partial Nephrectomy. Urology. Feb 2018;112:98-102. doi:10.1016/j.urology.2017.10.004
14. Bessede T, Bigot P, Bernhard JC, et al. Are warm ischemia and ischemia time still predictive factors of poor renal function after partial nephrectomy in the setting of elective indication? World J Urol. Jan 2015;33(1):11-15. doi:10.1007/s00345-014-1292-7
15. Simmons MN, Hillyer SP, Lee BH, et al. Functional recovery after partial nephrectomy: effects of volume loss and ischemic injury. J Urol. May 2012;187(5):1667-1673. doi:10.1016/j.juro.2011.12.068
16. Klatte T, Ficarra V, Gratzke C, et al. A Literature Review of Renal Surgical Anatomy and Surgical Strategies for Partial Nephrectomy. Eur Urol. Dec 2015;68(6):980-992. doi:10.1016/j.eururo.2015.04.010

Figure legends

Figure 1. Graphic flowchart of the study.

Figure 2 Parts a-c. Generation and validation of nomogram. (a) Predictive nomogram of long-term eGFR loss after all kinds of partial nephrectomy. (b) ROC curve of multivariable analysis. (c) Validation of predictive nomogram by calibration curve

BMI = body mass index; DM = diabetes mellitus; OT = operative time; DAP = Diameter-Axial-Polar score; eGFR = estimated glomerular filtration rate, AKI = acute kidney injury.

Tables

Table 1. Univariate logistic regression analysis to predict renal function variation

	Late > 25% loss of eGFR			AKI		
Variable	OR	95%CI	p value	OR	95%CI	p value
Age	1.04	1.01, 1.07	0.004	1.00	0.98, 1.02	0.72
Gender						
Female	Ref.			Ref.		
Male	2.61	1.38, 5.31	0.005	3.06	1.82, 5.36	<0.001
BMI	1.25	1.14, 1.38	<0.001	1.19	1.11, 1.29	<0.001
Diabetes						
Absent	Ref.			Ref.		
Present	4.03	2.06, 7.69	<0.001	1.39	0.72, 2.58	0.30
Hypertension						
Absent	Ref.			Ref.		
Present	2.43	1.38, 4.36	0.002	1.29	0.82, 2.02	0.27
Dyslipidemia						
Absent	Ref.			Ref.		
Present	1.93	1.07, 3.44	0.03	1.00	0.59, 1.66	0.99
Operative time	1.01	1.00, 1.02	0.002	1.02	1.01, 1.02	<0.001
OT >100	3.32	1.83, 6.29	<0.001	5.64	3.39, 9.71	<0.001
OT >110	4.17	2.35, 7.62	<0.001	3.36	2.12, 5.38	<0.001
EBL	1.00	0.998, 1.001	0.96	1.00	1.00, 1.00	0.14
Ischemia time	1.00	0.995, 1.014	0.40	1.04	1.01, 1.06	0.002
WIT>20min in LPN and RAPN	1.76	0.807, 4.161	0.17	1.99	1.08, 3.85	0.03
Uric acid preoperative	1.00	1.000, 1.006	0.02	1.00	1.00, 1.01	<0.001

eGFR preoperative	0.98	0.964, 0.991	0.0012	0.98	0.96, 0.99	<0.001
eGFR 1-day postoperative	0.96	0.944,0.971	<0.001			
AKI	7.52	4.18, 13.81	<0.001			
ZS score	1.27	1.11,1.46	<0.001	1.52	1.34, 1.74	<0.001
RENAL score	1.13	0.96, 1.33	0.15	1.51	1.31, 1.76	<0.001
PADUA score	1.09	0.93, 1.29	0.29	1.52	1.32, 1.77	<0.001
Diameter	1.29	1.09, 1.52	0.035	1.69	1.44, 2.00	<0.001
DAP score	1.39	1.05, 1.87	0.003	1.84	1.53, 2.23	<0.001
DAP diameter level						
< 2.4cm	Ref.			Ref.		
2.4cm - 4.4 cm	4.52	1.73, 15.49	0.006	1.82	0.97, 3.59	0.07
> 4.4cm	8.17	2.97, 28.85	<0.001	5.16	2.63, 10.66	<0.001
C-Index	0.58	0.42,0.78	<0.001	0.44	0.33, 0.58	<0.001
Invision score	1.15	1.01, 1.31	0.03	1.29	1.16, 1.44	<0.001
NePhRO score	1.27	1.09, 1.49	0.003	1.46	1.27, 1.68	<0.001

BMI = body mass index; eGFR = estimated glomerular filtration rate; OT = operative time; EBL = estimated blood loss; RENAL = Radius-Exophytic/Endophytic-Nearness-Anterior/Posterior-Location; DAP = Diameter-Axial-Polar; PADUA = Preoperative Aspects and Dimensions Used for an Anatomical score; ZS = Zhongshan; NePhRO = Zonal Nearness-Physical-Radius-Organization.

Table 2. Predictive factors of >25% loss of eGFR in long term follow-up based on multivariable logistic regression analysis.

	Multivariable model	
Variable	OR (95%CI)	*p* value
Age	1.05(1.02, 1.09)	**0.0039**
BMI	1.18(1.06, 1.33)	**0.0049**
Diabetes	2.51(1.05, 5.87)	**0.0351**
OT > 110 min	2.82(1.42, 5.75)	**0.0034**
Diameter level of DAP score		
< 2.4cm	Ref.	
2.4cm - 4.4 cm	3.73(1.33, 13.45)	**0.0225**
> 4.4cm	4.12(1.35, 15.64)	**0.0207**
AKI	5.07(2.56, 10.27)	**<0.001**

BMI = body mass index; OT = operative time; eGFR = estimated glomerular filtration rate; DAP = Diameter-Axial-Polar, AKI = acute kidney injury.

CONFLICT OF INTEREST

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5) Jiaqi Huang — no conflict
6) Jianming Guo — no conflict
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8) _____

I accept the responsibility for the completion of this document and attest to its validity on behalf of the co-authors.

Hang Wang (Type name above) — Aug 23 2022 (Date)

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