ORIGINAL ARTICLE

Predicting Factors of Renal Recoverability Post Percutaneous Nephrostomy for Obstructive Uropathy in Universiti Kebangsaan Malaysia Medical Centre (UKMMC)

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ABSTRACT

Introduction: Multiple factors predict the recoverability of renal function post percutaneous nephrostomy (PCN) in obstructive uropathy. The aim is to ascertain parameters with significant predictive value to aid in the stratification of patients requiring urgent PCN. **Materials and methods:** A retrospective study over a period of 5 years between January 2016 till January 2021 was conducted in Universiti Kebangsaan Malaysia Medical Centre (UKMMC) involving a total of 217 patients who underwent image guided PCN that met the inclusion criteria. The pre-intervention renal imaging, biochemical parameters and the post-intervention serum creatinine were obtained and respective estimated glomerular filtration rate (eGFR) calculated. Patients with post-intervention serum creatinine of less than 130 umol/L and eGFR of more than 60 were categorized as patients with good renal recovery. Subsequently, the significance of each parameter with good renal recovery was analysed. **Results:** There is significant correlation between the absence of chronic kidney disease and renal parenchymal disease, level of obstruction, age, renal size, hemoglobin, pre-intervention serum creatinine and eGFR with good renal recovery on bivariate analysis. However, only the absence of renal parenchymal disease, renal size of more than 11.2cm (S.D: 7.2 - 23.8) and pre-intervention eGFR of more than 23.0 (S.D: 2.2 - 168.0) remained statistically significant on multivariate analysis. **Conclusion:** Previous healthy kidneys with good size and function proves to be statistically significant in achieving the best recoverability which are applicable in stratification of PCN requests. A prospective study of a wider population will yield a farther accurate and generally pertinent result.
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Keywords: Percutaneous nephrostomy, Estimated glomerular filtration rate, Serum creatinine, Chronic kidney disease, Obstructive uropathy

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INTRODUCTION

Percutaneous nephrostomy (PCN) is a recognised minimally invasive treatment for hydronephrosis, since as early as 1955 as described by Goodwin et. al. in cases of marked hydronephrosis caused by urinary tract obstruction [1]. Imaging guided PCN remains a relatively safe and considerably technically successful procedure to attain access to the renal collecting system for various objectives [2]. Indications for image guided PCN placement can be divided into four general objectives namely for relief of urinary tract obstruction, to obtain sample for diagnostic testing, as access for therapeutic interventions and for diversion of urinary system. To ascertain the requirement of percutaneous nephrostomy placement, familiarity with the clinical presentation, diagnostic work-up and management in the setting of each specific indication are essential [1].

Obstruction of the urinary tract may be caused by either intrinsic or extrinsic ureteral obstruction that can be inflicted by calculus, malignancy or iatrogenic aetiologies. Urinary tract obstruction is often diagnosed upon presentation with azotemia, urosepsis or even as an incidental finding on imaging studies. It persists as the predominant indication for percutaneous nephrostomy placement, prevailing as high as 87% in most institutions [3].

Compromise in the normal outflow of the urinary tract results in retrograde pressure build up into the renal collecting system which leads to dilatation of the urinary tract. Consequently, the renal filtration system is impaired. The intrinsic mechanism of nephropathy at this juncture is multifactorial, including local ischemia

caused by distention and increased intratubular pressures. Angiotensin and AT1-receptor apparently are known to be upregulated in the setting of obstruction. This effectively increases ureteral peristalsis which is aimed to help relieve the obstruction. While peristaltic function may be of benefit in a partial obstruction, it is likely to cause increased distension and intraluminal pressure when the obstruction is complete [4, 5].

Acute urinary tract obstruction has greater tendency to be reversible and less likely to produce damage to the renal filtration system and its functions. In contrary, chronic obstruction produces worse long-term effects on the renal function. Obstruction can subsequently lead to permanent impairment and eventually renal failure. While this is less likely to occur during an acute obstruction, the possibility of this course cannot be completely excluded [4]. With its known course of illness, the resultant obstructive uropathy may progress into a potentially life threatening condition. Therefore, immediate measures are executed to decompress the kidneys [6].

Several studies have been carried out to predict the recoverability of the renal function of obstructed kidney or kidneys by means of decompression via PCN. A range of parameters were advocated which yielded variable results, some of which were significant. All reviewed studies were based on populations of different countries [5-11]. There is yet a similar study on our local population in Malaysia. There are several requests for urgent PCNs among other procedures done in the angiography suite of our tertiary centre on a regular basis. This study was designed to gauge the predicting factors of renal recoverability in patients with obstructive uropathy in our tertiary centre population. The outcome will enable prediction of the renal function recoverability among obstructive uropathy patients based on significant parameters. Thenceforth, aid in stratifying the requests for urgent PCN. Hence, patients with the most potential for recovery can be prioritized.

MATERIALS AND METHODS

This is a retrospective study using universal sampling of all adult patients who underwent imaging guided PCN in our interventional radiology unit over a span of 5 years from January 2016 till January 2021, of which a list of 284 subjects were attained from the hospital database. The inclusion criteria were adult patients aged above 18 years who underwent imaging guided PCN in our center with available pre-intervention renal imaging; USG (Ultrasound) or CT (Computed tomography), hemoglobin (Hb), white blood count (WBC), serum creatinine and post-intervention serum creatinine repeated at day 3-5, day 7-10 and after day 30 post-intervention. Pediatric patients and subjects with incomplete data were excluded from the study.

All subjects received similar operator's skill level and technique as per standard operating protocol performed by qualified interventional radiologists under ultrasound and fluoroscopic imaging guidance.

The demographic, clinical, pre- and post-intervention parameters were obtained from the Integrated Radiology Information System (IRIS) and Caring Hospital Enterprise System (C-HETS). Co-morbidity status of chronic kidney disease is reviewed from the clinical diagnosis based on eGFR of less than 60 over at least 3 consecutive months. The renal imaging parameters were evaluated on the standardized OsirixR software used in our center. Presence of renal parenchymal disease was determined based on sonographic evaluation of the renal parenchyma, increased echogenicity as compared to the liver or spleen is considered as presence of renal parenchymal disease. Degree of hydronephrosis was graded based on the Society of Fetal Urology (SFU) hydronephrosis grading system [12]. The pre- and post-intervention eGFR were calculated using the "modification of diet in renal disease" (MDRD) formula.

Each subject was segregated into the good and poor recovery categories based on the post-intervention serum creatinine and eGFR. Good renal recovery was defined by post-intervention serum creatinine of less than 130 umol/L and eGFR of more than 60 and vice versa.

Statistical analysis was done using IBM SPSS Statistics Version 26.0 for MAC IOS (Chicago, IL, USA). The frequency and percentage of each categorical variable; age, gender, co-morbidity status, renal parenchymal disease, degree of hydronephrosis and level of obstruction and dependent variable; good or poor recovery were analyzed. The numerical variables; pre-intervention renal size, renal parenchymal thickness, Hb, WBC, serum creatinine and eGFR were analyzed for their mean, median, standard deviation and interquartile range. Bivariate analysis was then performed to study the correlation between each categorical and numerical variable and the dependent variable using the Pearson's Chi-Square test and Fisher's Exact test for categorical variables and independent t-test for the numerical variables. All variables with a P value of < 0.25 on the initial bivariate analysis were then subjected to a multivariate analysis using logistic regression to further evaluate the statistical significance of these variables in the renal recoverability of patients post PCN.

This study design and the methodology carried out was approved by the ethics committee of our tertiary centre (ethics approved project code: FF-2021-148).

RESULTS

217 subjects were eligible out of the 284-subject list

obtained from the hospital database that fulfilled the inclusion criteria. In the excluded 67 subjects, 14 did not have the procedure done, 13 were pediatric patients, 8 had the procedure done for indications other than obstructive uropathy while the remaining 32 subjects had incomplete data for analysis [13].

Male patients predominated, at 54.8% (n = 119) and 45.2% (n = 98) were female patients [Table I]. The subjects' age ranged from 18 to 86 years old with a median age of 63 years [Table I]. In regards to their co-morbidities, most of the subjects have had been diagnosed with hypertension (62.2%; n = 135) and mostly did not suffer from diabetes mellitus (62.2%; n = 135) or chronic kidney disease (83.9%; n = 182) [Table I].

Table I: Descriptive and bivariate analysis of categorical and numerical variables.

Variables	Frequency, n (%) / Median (IQR)	Recoverability, n (%) / Mean (SD)		p-value
		Yes	No	
Gender				
• Male	119 (54.8)	41 (34.5)	78 (65.5)	0.258[a]
• Female	98 (45.2)	41 (41.8)	57 (58.2)	
Co-Morbidity:				
• Hypertension (Yes / No)	135 (62.2) / 82 (37.8)	50 (37.0)	85 (63.0)	0.574[a]
• Diabetes Mellitus (Yes / No)	82 (37.8) / 135 (62.2)	30 (36.6)	52 (63.4)	0.588[a]
• Chronic Kidney Disease (Yes / No)	35 (16.1) / 182 (83.9)	4 (11.4)	31 (88.6)	<0.001[a]
Level of Obstruction				
• Upper	134 (61.8)	58 (43.3)	76 (56.7)	
• Lower	82 (37.8)	24 (29.3)	58 (70.7)	0.077[b]
• Both	1 (0.5)	0 (0.0)	1 (100.0)	
Degree of Hydronephrosis				
• 1	44 (20.9)	22 (50.0)	22 (50.0)	
• 2	94 (44.8)	33 (35.1)	61 (64.9)	0.391[b]
• 3	50 (23.8)	18 (36.0)	32 (64.0)	
• 4	22 (10.5)	8 (36.4)	14 (63.6)	
Renal Parenchymal Disease (Yes / No)	65 (30.8) / 146 (69.2)	16 (24.6)	49 (75.4)	0.007[a]
Age (years)	63 (18 - 86)	58.2 (14.2)	62.7 (12.5)	0.017[c]
Renal Size (cm)	11.2 (7.2 - 23.8)	12.0 (2.3)	11.4 (2.1)	0.097[c]
Parenchymal Thickness (cm)	1.3 (0.2 - 3.0)	1.2 (0.6)	1.2 (0.6)	0.487[c]
Haemoglobin (g/dL)	10.5 (6.1 - 16.3)	11.4 (2.2)	10.5 (2.0)	0.002[c]
White Blood Count	11.0 (3.8 - 54.0)	13.2 (7.5)	12.5 (6.2)	0.437[c]
Pre-PCN Serum Creatinine (umol/L)	214.7 (46.7 - 1601.3)	208.8 (270.9)	421.2 (310.5)	<0.001[c]
Pre-PCN eGFR	23.0 (2.2 - 168.0)	54.9 (34.5)	21.0 (18.6)	<0.001[c]

[a] Pearson's Chi-Square Test, [b] Fisher's Exact Test, [c] Independent T-Test

The pre-intervention renal imaging revealed that upper urinary tract obstruction which included the pelvicalyceal system, ureter and vesicoureteric junction was the commonest as identified in 61.8% (n = 134) of subjects. Only 37.8% (n = 82) of the subjects had lower urinary tract obstruction which involved the urinary bladder and its outlet [14]. Only 1 subject unfortunately suffered from both upper and lower tract obstructions [Table I]. 44.8% which involved 94 subjects had grade 2 hydronephrosis at the time of requiring PCN. This is followed by 23.8% (n = 50) with grade 3, 20.9% (n = 44) with grade 1 and lastly 10.5% (n = 22) with grade 4 hydronephrosis [Table I]. Majority of the subjects that underwent imaging guided PCN did not have renal parenchymal disease (69.2%; n = 146) with only 30.8% (n = 65) detected to have the condition [Table I]. The renal size and parenchymal thickness ranged from 7.2

Bivariate analysis of the categorical and numerical variables were initially run. Pearson's Chi-Square test and Fisher's Exact test of the categorical variables demonstrated that the absence of chronic kidney disease and renal parenchymal disease had a significant correlation in achieving good renal recovery (P value < 0.05). Whereas, the level of obstruction had a borderline significance in correlation with a P value of less than 0.250. The rest of the variables namely patient's gender, absence of hypertension or diabetes mellitus and the degree of hydronephrosis were insignificant in attaining good renal recovery post intervention [Table I]. The independent t-test performed on numerical variables revealed patient's age, renal size, renal parenchymal thickness, serum Hb level, pre-intervention serum creatinine and eGFR showed significant correlation with good renal recovery (P value < 0.05) [Table I].

to 23.8cm and 0.2 to 3.0cm with a mean of 11.6cm (median : 11.2cm; S.D. = 2.2) and 1.2cm (median : 1.3cm; S.D. = 0.6) respectively [Table I].

Pre-intervention biochemical parameters showed that the Hb levels range from 6.1 to 16.3g/dL with a mean of 10.8g/dL (median : 10.5g/dL; S.D. = 2.1). The WBC ranged from 3.8 to 54.0 with a mean of 12.8 (median : 11.0; S.D. = 6.7). Pre-intervention serum creatinine of the subjects ranged from 46.7 to 1601.3umol/L with a mean of 341.3umol/L (median : 214.7umol/L; S.D. = 313.1). The calculated eGFR ranged from 2.2 to 168.0 with a mean of 33.8 (median : 23.0; S.D. = 30.5) [Table I].

The post intervention outcome of each subject which was allotted into good or poor renal recovery categories revealed that out of the 217 subjects analyzed only 37.8% (n = 82) established good recovery while the remaining majority of 62.2% (n = 135) showed poor recovery despite the procedure [Table I, Figure 1].

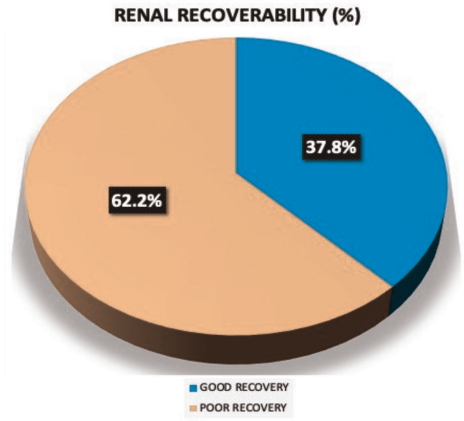

Figure 1: Pie chart representation of the percentage of subjects with good and poor renal recovery post-PCN.

Multivariate analysis using logistic regression was finally done for all the categorical and numerical variables of significance with P value of at least 0.250. Evidently, only absence of renal parenchymal disease, renal size and pre-intervention eGFR remained statistically significant in correlation with a good renal recovery outcome. This ascertains that these variables play a crucial role in predicting the potential for renal recoverability. The rest of the variables namely absence of chronic kidney disease, level of obstruction, patient's age, Hb and pre-intervention serum creatinine lost their significance after the multivariate analysis [Table II].

Table II: Multivariate analysis of variables using logistic regression analysis.

Variables	B	S.E	Exp (B)	95% CI	p-value
Chronic Kidney Disease	0.453	0.655	1.573	0.436, 5.676	0.489
Level of Obstruction (Both)					
Level of Obstruction (Upper)	20.770	40193.741	1.048E+9	0.000	0.957
Level of Obstruction (Lower)	20.898	40193.741	1.190E+9	0.000	
Renal Parenchymal Disease	1.030	0.461	2.801	1.134, 6.919	0.026
Age (years)	-0.020	0.015	0.980	0.951, 1.010	0.189
Renal Size (cm)	0.185	0.081	1.203	1.026, 1.410	0.023
Haemoglobin (g/dL)	0.095	0.096	1.100	0.911, 1.327	0.322
Pre-PCN Serum Creatinine (umol/L)	0.000	0.001	1.000	0.999, 1.002	0.567
Pre-PCN eGFR	0.052	0.011	1.054	1.031, 1.077	<0.001

CONTINUE

Table II: Multivariate analysis of variables using logistic regression analysis (CONT').

Variables	B	S.E	Exp (B)	95% CI	p-value

*PCN: Percutaneous Nephrostomy, p-value < 0.05.

DISCUSSION

This current study dissects the possible factors that could predict the potential of renal recoverability post PCN aimed to aid in stratification and prioritization of patients requiring PCN. A retrospective study was carried out and bi- and multivariate analysis applied to study the significance of the possible factors.

A number of similar studies have been carried out in various settings. However, most studies dissected only limited variables [5-11]. Therefore, this study is designed for a more wholesome approach in attempt to encompass all the possible aspects that could influence the recoverability of patients' renal function with the insertion of PCN. Hence, the incorporation of demographic data, imaging and biochemical parameters of each patient. To the best of our knowledge from literature reviews, this is the first study to examine the significance of various variables from a diverse aspect.

A frequent indication for urgent PCN in our center

was urosepsis. Thus, WBC was included as a pre-intervention variable. However, the statistical analysis within the limits of this study revealed that there was no significant role of the WBC cutoff value in predicting the potential for renal recovery. Nevertheless, there are many other relevant factors that influence the clinical status of patients in sepsis. Hence, exploring other factors attributable to urosepsis may be deemed relevant in future studies.

The statistical analysis revealed that albeit multiple variables were significant on bivariate analysis, mostly loss its significance on multivariate logistic regression analysis. Multivariate analysis has the advantage of taking into account various variables and their relative influence between each other and their impact onto the dependent variable. Hence, giving a more accurate and representative outcome in reality where all variables are interrelated and co-existing. Thenceforth, only the absence of renal parenchymal disease, renal size of more than 11.2cm (S.D: 7.2 - 23.8) and pre-intervention eGFR of more than 23.0 (S.D: 2.2 - 168.0) had significant correlation in predicting the probability of renal recoverability. A number of various studies done by Sasmol S. et.al, Sharma U. et.al, Rajadoss MP. et.al and Soeroto AA. et.al in regards to renal recovery in obstructive uropathy also relayed similar outcomes after multivariate analysis [7-9, 11]. Therefore, the aforementioned factors are hence applicable in daily practice to help stratify which patient would benefit most and should be prioritized for PCN insertion.

Limitations of this study include its small sample size of cases only done in the setting of our center. This renders the outcome of this study only better applicable to the localized population in this region and rather less representative of the national or international general population. A larger sample size of a broader range of population would consequently provide a better representation of the general population. Hence, more pertinent in the daily practice involving a wider range of patients nationally and internationally. In regards to the studied parameters, the influence of an atrophic kidney commonly seen in chronic kidney disease may potentially skew the renal size reducing accuracy of the variable. This should be considered in future studies. Apart from that, the fact that this a retrospective study also causes a number of shortcomings. These include numerous subjects being excluded due to incomplete data from loss or defaulted follow-up as well as non-standardized follow-up timings and parameters. A prospective study would give the benefit of a more structured pre- and post-intervention follow-up and standardized data source and collection which mainly concerns the imaging related parameters.

CONCLUSION

This study demonstrates the absence of renal parenchymal disease, renal size of more than 11.2cm (S.D: 7.2 - 23.8) and pre-intervention eGFR of more than 23.0 (S.D: 2.2 - 168.0) are significant factors in predicting renal recoverability post percutaneous nephrostomy, hence applicable in daily practice to stratify which patient would benefit most and should be prioritized for PCN insertion. A prospective study at a larger scale, involving a wider range of population would be ideal and able to generate a more commonly applicable outcome.

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