Medical Scope Journal 2024;6(2):172-178
DOI: https://doi.org/10.35790/msj.v6i2.52858
URL Homepage: https://ejournal.unsrat.ac.id/index.php/msj

The Importance of Preoperative Evaluation to Predict the Outcome of Percutaneous Nephrostomy

Ronald J. Datu,[1] Eko Arianto,[2] Ari Astram,[2] Christof Toreh[2]

[1]Department of Surgery, Faculty of Medicine, Universitas Sam Ratulangi, Manado, Indonesia
[2]Division of Urology, Department of Surgery, Faculty of Medicine, Universitas Sam Ratulangi, Manado, Indonesia
Email: ronaldjdatu@gmail.com
Received: December 10, 2023; Accepted: January 15, 2024; Published online: January 28, 2024

Abstract: Percutaneous nephrostomy (PCN) is an invasive procedure equal to a grade 4 penetrating kidney trauma. It should be carefully considered whether has a greater benefit or risk. There are currently no parameters or scores to predict the outcome of nephrostomy in our center. This study aimed to conduct a review to find out whether there were parameters or scores that could be used to predict the outcome of nephrostomy. This research used relevant studies obtained from Clinical Key, PubMed, Semantic Scholar, Dimensions, and Science Direct published in the last 10 years and written in English. Studies on children and transplant cases were excluded. Studies that met the PICO criteria were selected. The results showed that of the 141 articles collected, and filtered with inclusion criteria, exclusion criteria, and PICO criteria, finally the remaining were three studies selected. The studies discussed about classification, SFU grading system, and complication of nephrostomy; significant variables affecting recoverability of renal function; patients' characteristics and outcomes of double J ureteral stenting (DJS) and PCN; and 12-month-post-operative creatinine level change. Most patients who failed DJS had increased creatinine level. However, one of the indications for a nephrostomy was stenting failure. In conclusion, predictor factors that can affect the renal recovery after nephrostomy include kidney shape and size, pre-nephrostomy creatinine levels, urine output, state of infection, and degree of hydronephrosis. However, the evidence is still not enough. Further research is needed on the predictor factors for renal recovery after nephrostomy.
Keywords: percutaneous nephrostomy; hydronephrosis; kidney function; outcome predictors

INTRODUCTION

Hydronephrosis is a medical condition when there is unilateral or bilateral dilation of the renal pelvis and calyceal system.[1] Hydronephrosis can be caused by internal obstruction and external obstruction. Internal obstruction arises within the urinary tract such as urinary tract stones or tumor of genitourinary tract meanwhile external obstruction can be caused by external compression including retroperitoneal fibrosis or malignancies (gastrointestinal, gynecological, lymphoma malignancy and others.[1-3]

Hydronephrosis should be treated as soon as possible, since prolonged obstruction often causes symptoms such as infection, flank pain, and decrease in renal function.[3] It is a potentially life-threatening condition and if the obstruction is present bilaterally then immediate treatments are required to decompress the kidney, otherwise the patient's clinical conditions will deteriorate quickly through uremia, water-electrolyte abnormalities, and urinary infections with a consequent fatality. Urinary diversion is an option to manage ureteral obstructions and is commonly performed when the underlying pathology of ureteral obstruction cannot be eliminated immediately. Currently, double-J ureteral stenting (DJS) and ultrasound guided percutaneous nephrostomy (PCN) tube insertion are the most widely used techniques for relieving obstruction of the urinary tract.[4] Nephrostomies are used in patients with high risk of anaesthesia or DJS insertion has failed.[1]

However, nephrostomy is an invasive procedure equal to a grade 4 penetrating kidney trauma. In treating patients, we should avoid harm as much as possible. It should be carefully considered whether a procedure has a greater benefit or risk.[5-7] Especially at the time of pandemic such as COVID-19 pandemic where we must avoid exposure and only perform procedures that are absolutely necessary.

There are currently no parameters or scores to predict the outcome of nephrostomy in our center. Thus, we are interested in conducting a review to find out whether there are parameters or scores that can be used to predict outcome of nephrostomy. This study is a pilot study for future studies that is planned to perform in our center.

METHODS

Relevant studies were obtained from Clinical Key, PubMed, Semantic Scholar, Dimensions, and Science Direct. We used "(hydronephrosis) AND (percutaneous nephrostomy) AND (predictor OR outcome OR kidney function)" as keywords. All keywords were searched for their respective MeSH thesaurus. The inclusion criteria were article in English published in the last 10 years, meanwhile the exclusion criteria were children and transplant cases.

RESULTS

The literature searching was limited by using inclusion and exclusion criteria. The literature search was started by using several search engines including Clinical Key, PubMed, Semantic Scholar, Dimensions, and Science Direct, then by using keywords to filter articles that match the topic. By using the exclusion criteria, 20 articles were netted. Then the screening of duplicated studies was carried out and the suitability of the study with the PICO criteria that we made, and finally the remaining three studies were selected.

Table 1 showed the classification of hydronephrosis based on cause, involved kidney, complete or partial obstruction, and intrinsic or extrinsic origin.

Table 1. Classification of hydronephrosis[1]

Classification of hydronephrosis	
Cause	Congenital, eg posterior urethral valve Acquired, eg calculus obstruction
Level	Upper tract: ureter or above; lower tract: bladder or below
Unilateral or bilateral	Both kidneys are usually involved in lower tract obstruction An individual kidney can be affected by upper tract obstruction

Classification of hydronephrosis	
Complete or partial	Complete obstruction is the most common cause of anuria Partial: can be challenging to diagnose, urine output may vary
Intrinsic or extrinsic origin	Intrinsic: arising within the urinary tract, eg ureteric stone Extrinsic: arising externally, eg tumours

Table 2 showed the Society of Fetal Urology (SFU) grading system of hydronephrosis with five grades of renal pelvic dilation (Grade 0 – Grade 4).

Table 2. SFU grading system of hydronephrosis[8]

Grading system	Renal pelvic dilation
Grade 0	No renal pelvic dilation
Grade 1	Mild renal pelvic dilation
Grade 2	Moderate renal pelvic dilation
Grade 3	Renal pelvic dilation along with all calyceal dilatation
Grade 4	Renal pelvic dilation along with all calyceal dilatation with thinning of the renal parenchym

Table 3 showed the complications of nephrostomy with septic shock as the most frequent one, followed by complication resulting in unexpected transfer to an intensive care unit, emergency surgery or delayed discharge.

Table 3. Complication of nephrostomy[4]

Complication	Incidence (%)
Septic shock requiring major increase in level of care	4
Septic shock (in setting of pyonephrosis)	10
Haemorrhage requiring transfusion	4
Vascular injury (requiring embolization or nephrectomy)	1
Bowel transgression	<1
Pleural complication	<1
Complication resulting in unexpected transfer to an intensive care unit, emergency surgery or delayed discharge	5

Table 4 showed the correlation between categorical variables and differential % CrCl of the Ipsilateral Kidney (Univariate Analysis) with all p-values less than 0,05.

Table 4. Correlation between categorical variables and differential % CrCl of the ipsilateral kidney (univariate analysis)[5]

Variables	Kidneys (n)	Differential % CrCl	p*
Parenchymal echogenicity			
Normal	91	35.53	0.0001
Abnormal	69	15.94	
Corticomedullary differentiation			
Normal	103	32.2	0.0001
Abnormal	57	13.05	
Degree of hydronephrosis			
Moderate (grade 3)	56	28.42	0.018
Severe (grade 4)	101	23.60	
Presence of infection			
Yes	61	15.93	0.0001
No	99	31.20	
Status of opposite kidney			
Normal	59	22.10	0.002
Abnormal	101	27.29	

*Mann-Whitney U-test. Data in parenthesis are percentages; CrCl: Creatinine clearance

Table 5 showed significant variables affecting recoverability of renal function using multivariate analysis with p-value less than 0.05.

Table 5. Significant variables affecting recoverability of renal function using multivariate analysis (multiple regression)[5]

Variables	Regression estimate (B)	SE (B)	p
CT	-0.563	0.151	0.0001
Echogenicity	-10.228	2.74	0.0001
CMD	-13.239	1.595	0.0001
Urine pH	-7.968	1.64	0.0001
Pre-PCN creatinin	0.666	0.250	0.009
Status of opposite kidney	3.297	1.528	0.032

CMD: Corticomedullary differentiation, CT: Cortical thickness; PCN: Percutaneous nephrostomy, SE: Standard error

Table 6 showed the patients' characteristics and outcomes of pre-drainage and post-drainage outcome between DJS and PCN. Most characteristics showed no significant differences between them; only those written in bold showed significant differences.

Table 6. Patients' characteristics and outcomes[6]

Patients' characteristics and outcomes	DJS ($n = 45$)	PCN ($n = 30$)	p-value
Pre-drainage patients' characteristics			
Age (years)	55 (39.5–70.5)	54 (46.5–61)	0.787
Gender- Female	15 (33%)	13 (43%)	0.467
BMI (kg/m^2)	27.6 (24.8–30.1)	27.7 (23.3–31)	0.944
Hypertension	24 (53.3%)	13 (43.3%)	0.683
Diabetes mellitus	14 (31.1%)	7 (23.3%)	0.622
Ischemic heart disease	8 (17.7%)	7 (23.3%)	0.775
Previous endourological procedures	14 (31.1%)	9 (30%)	1
Baseline eGFR (MDRD, mL/min/1.73 m^2)	85.5 (69.3–90.6)	69 (58.1–80.4)	**0.001**
eGFR at presentation (MDRD, mL/min/1.73 m^2)	60.3 (41.3–75.6)	41.2 (33–59)	**0.011**
Positive urine cultures	25.6%	40.7%	0.199
Indication for drainage – Fever≥30ºc	15 (33.3%)	16 (53.3%)	0.099
Indication for drainage - Renal Failure (eGFR≤60 mL/min/1.73 m^2)	10 (22.2%)	10 (33.3%)	0.301
Stone diameter (mm)	8 (7–11)	8 (6–12.3)	0.872
Stone location-Proximal	55%	64%	0.469
Stone location-Distal	45%	36%	0.469
Post drainage outcomes			
Post procedure hospitalization Days	1 (1–3)	4 (2–6)	**<0.001**
Post Procedural Pain (VAS)	1.02 ± 2.04	1.19 ± 1.52	0.283
Days to baseline eGFR [@]	1 (1–2)	2 (1–3)	**0.005**
Days to Temp ≤37.5 [@@]	1 (1–1.5)	1 (1–1.75)	1
Time to WBC ≤10,000 white blood cells per microliter (days) [@@@]	1.5 (1–2)	2 (1–4)	0.167
Complications 1st procedure	6 (11%)	1 (3.3%)	0.226
Time from 1st to 2nd operation (Days)	47 (29–71)	20 (12–27)	**<0.001**

Data presented as Median (IQR 25–75) or Mean ± STD as appropriate; MDRD The Modification of Diet in Renal Disease Study equation; [@] For patients with renal failure at presentation; [@@] For patients with fever at presentation; [@@@] For patients with leukocytosis at presentation; In bold - statistically significant result

Table 7 showed the characteristics of patients with double J ureteral stenting with a total number of 61. Most characteristics showed higher ratio of fail compared to not fail, and only those written in bold showed higher ratio of not fail.

Table 7. Ureteral stent (DJS) profile[3]

Characteristic of patients			No. of DJs (fail/not fail)
Total stent number			61 (31/30)
Age	≤60 years		30 (12/18)
	>60 years		31 (19/12)
Gender	Male		3 (2/1)
	Female		58 (29/29)
Cancer type	Gastrointestinal		
	Gynecological	Cervial cancer	32 (19/13)
		Ovarian cancer	6 (4/2)
		Benign myoma	**12 (2/10)**
Hydronephrosis grade	Mild		**31 (10/21)**
	Moderate		21 (14/7)
	Severe		9 (7/2)
Obstruction site	Lower		37 (23/14)
	Non- lower		**24 (8/16)**
Pyuria	No		**11 (1/10)**
			50 (30/20)
Unilateral or bilateral	Unilateral		**34 (15/19)**
	Bilateral		27 (16/11)
Laterality	Left		31 (17/14)
	Right		**30 (14/16)**

Table 8 showed the causes of 31 stent failure and the most frequent one was increase in creatinine followed by change to PCN.

Table 8. Causes of stent failure[3]

Causes of stent failure	Number (%)
Total failure number	31
Change to PCN	12 (38.7%)
Increase in creatinine	13 (41.9%)
Hydronephrosis upgrade	4 (12.9%)
DJ dislodgment or malposition	2 (6.4%)

PCN: percutaneous nephrostomy; Change to PCN: The ureteral stent could not be replaced or at the discretion of each attending urologist.

Table 9 showed the change of creatinine level in 12-month post operation. The most frequent change was positive creatinine change.

Table 9. Post-operative creatinine level at 12 months[3]

Creatinine level	No fail	Fail
Creatinine negative	9	8
Creatinine positive	17	22
NA	4	1

Creatinine = (Postop 12 months Cr – Preop Cr)/(Pre-op Cr); Creatinine ≥0: Creatinine-positive; Creatinine <0: Creatinine- negative.

DISCUSSION

Hydronephrosis is a medical condition of unilateral or bilateral dilation of the renal pelvis and calyx system.[1] Obstruction is often present, but this is not always the case. There are many causes of a dilated renal collecting system, and ultrasound is the initial imaging modality of choice for the majority of these assessments (Table 1).[7]

Hydronephrosis can be graded according to the SFU grading system. This grading system has been developed since 1993. It is quantitative and subjective with five grades of renal pelvic dilation (Table 2).[8]

Hydronephrosis should be approached initially with a thorough abdominal examination and a focused history.[1] Imaging studies are very useful investigation in diagnosing hydronephrosis.[9] Ultrasound is an excellent initial test, especially for children and pregnant women, with evaluation of the kidneys, portions of the ureters, bladder wall, bladder volume, and contour of the collecting system and ureters. Point-of-care ultrasound provides early, rapid imaging and aids patient triage and justification for additional imaging. Ultrasound is more than 90% sensitive and specific for hydronephrosis. Although not definitive, the absence of ureteral jets on ultrasound may be an indirect sign of obstruction. Abdominal, plain film, or kidney, ureter, and bladder (KUB) radiographs have limited diagnostic value unless conducted with contrast (IVU), may demonstrate radiopaque kidney or ureteral stones. Abdominal CT scan without intravenous contrast medium localizes sites of obstruction, especially if a ureteral calculus is the cause of obstruction. A normal ureteral width by unenhanced CT is 2 to 3 mm wide in adults. If kidney function is normal, CT urography (without and then with contrast, and with delayed images of the ureters), provides anatomic information and is the modality of choice for assessment of upper tract tumors or incidental hydronephrosis.[9-11]

In relation to treatment option of hydronephrosis, decompression of the upper urinary tracts can be performed with a nephrostomy inserted under radiological guidance. Nephrostomies are used in patients who unable to tolerate general anaesthesia or where a DJS insertion has failed. Also, when there is a large staghorn calculus causing hydronephrosis, a nephrostomy decompresses the upper urinary tract initially and then provides access for percutaneous nephrolithotomy to allow definite fragmentation of the stone. In pyonephrosis, nephrostomy must be done urgently.[1]

Regarding to complication of nephrostomy, percutaneous nephrostomy (PCN) insertion is a commonly performed interventional procedure, mostly for the relief of renal obstruction, with or without associated infection, and some further complications are listed in Table 3.

Referring to predictor factors of renal function recovery after percutaneous nephrostomy, the first article written by Sharma et al[5] discussed the factors influencing recoverability of kidney function after PCN. This study showed that cortical thickness, parenchymal echogenicity, corticomedullary differentiation, pre percutaneous nephrostomy creatinine, and contralateral kidney status were independent variables that could predict kidney function when other variables such as kidney size, urine output, infection, degree of hydronephrosis, although had a significant effect on renal function lost statistically significant on multivariate analysis (Table 4 and 5).[5]

The second article written by Shoshany et al,[6] discussed clinical outcomes and quality of life for DJS versus PCN. In this study, samples were taken of 30 patients who underwent percutaneous nephrostomy with a baseline eGFR of pre-drainage of 69 (58.1-80.4) mL/min/1.73 m^2, then the outcome of post drainage was re-evaluated. Days to baseline eGFR for patients with renal failure at presentation was 2 (1-3) days. Actually, the data in this study were not directly related to the predictor factors for the outcome of percutaneous nephrostomy, but at least the necessary data can be extracted such as the time it took to return to the baseline eGFR after drainage (Table 6).[6]

The third article written by Wu et al[3] actually discussed the clinical predictors of ureteral stent failure in patients with external ureteral compression. However, as we know that one of the indications for a nephrostomy is stenting failure. From 31 mild hydronephrosis, 10 failed ureteral stents while 21 were successful. Of the 21 moderate hydronephrosis, 14 failed to do stenting and seven were successful. Of the nine severe hydronephrosis, seven failed to perform a ureteral stent and two successfully performed a stent. Of the total 31 patients who failed to have ureteral stent, 12 patients changed to PCN or 38.7%. Post-operative creatinine level change after 12 months was seen from 31 patients who failed ureteral stent, 22 patients had an increase in creatinine, eight patients had a decrease in creatinine, and one patient did not have an increase or decrease in creatinine (Table 7-9).[3]

CONCLUSION

Predictor factors that can affect the renal recovery after nephrostomy include kidney shape and size, pre-nephrostomy creatinine levels, urine output, state of infection, and degree of hydronephrosis. However, the evidence is still not enough. Further research is needed on the predictor factors for renal recovery after nephrostomy.

This research has not developed much, therefore we decided to continue the study with original data from our center. After all, the Covid-19 pandemic may be a blessing in disguise for us to treat our patients as humanly as possible for the first oath we took is "primum non nocere."

Conflict of Interest

The authors affirm no conflict of interest in this study.

REFERENCES

1. Patel K, Batura D. An overview of hydronephrosis in adults. Br J Hosp Med. 2020;81(1):1-8. Doi 10.12968/hmed.2019.0274
2. Haas CR, Shah O, Hyams ES. Temporal trends and practice patterns for inpatient management of malignant extrinsic ureteral obstruction in the United States. Journal of Endourology. 2020;34(8):828-35. Doi: 10.1089/end.2020.0053
3. Wu KJ, Chen YZ, Chen M, Chen YH. Clinical factors predicting ureteral stent failure in patients with external ureteral compression. Open Med (Wars). 2021;16(1):1299-305. Doi: 10.1515/med-2021-0345
4. Ahmad I, Pansota MS, Tariq M, Saleem MS, Tabassum SA, Hussain A. Comparison between double J (DJ) Ureteral stenting and percutaneous nephrostomy (PCN) in obstructive uropathy. Pak J Med Sci 2013;29(3):725-9. Doi: 10.12669/pjms.293.3563
5. Sharma U, Yadav SS, Tomar V. Factors influencing recoverability of renal function after urinary diversion through percutaneous nephrostomy. Urol Ann. 2015;7(4):499-503. Doi: 10.4103/0974-7796.157960
6. Shoshany O, Erlich T, Golan S, Kleinmann N, Baniel J, Rosenzweig B, Et al. Ureteric stent versus percutaneous nephrostomy for acute ureteral obstruction - clinical outcome and quality of life: a bi-center prospective study. BMC Uroloogy. 2019;19(1):305. Doi: 10.1186/s12894-019-0510-4
7. Tublin M, Levine D, Thurston W, Wilson SR. The kidney and urinary tract. In: Rumack CM, Levine D, editors. Diagnostic Ultrasound (5th ed). Philadelphia, PA: Elsevier; 2018. p. 316-7.
8. Onen A. Grading of hydronephrosis: an ongoing challenge. Front Pediatr. 2020;8:458. Doi: 10.3389/fped.2020.00458
9. Kovacevic N, Leavitt D. Hydronephrosis. In: Ferri FF, editor. Ferri's Clinical Advisor 2022. Philadelphia: Elsevier; 2022. p. 783-4.
10. Adam A, Dixon AK, Gillard JH, Schaefer-Prokop C. Grainger and Allison's Diagnostic Radiology (7th ed). E-book Elsevier Health Sciences; 2020. p. 2182-5.
11. Patel U, Ratnam L. Vascular genitourinary tract intervention. In: Lee MJ, editor. Grainger Allison’s AA Diagnostic Radiology: Interventional Imaging. España: Elsevier Health Sciences; 2015. p. 195.