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Review of factors affecting total blood loss and need for blood transfusion in a series of patient undergoing unilateral percutaneous nephrolithotomy

Abstract

Purpose: Although percutaneous nephrolithotomy (PNL) has been accepted as a standard method for the management of large renal stones, the incidence of renal hemorrhage is relatively high. This study investigated the variables that affect Haemoglobin (Hb) drop and blood transfusion need during PNL.

Materials and methods: The medical records of 200 patients who underwent unilateral PCNL from January 2014 to October 2015 were recorded prospectively. Various clinical preoperative, perioperative and postoperative factors including age, sex, body mass index, diabetes mellitus, hypertention, preoperative creatinine level, previous renal surgery, renalanomalies, history of extracorporeal shock wave lithotripsy (SWL), stone size, stone site, stone complexity (GUY 's Stone Scoring System; SSS), degree of hydronephrosis, operative time, type of anesthesia, number of puncture, size of amplatze, method of stentting (double J or ureteric stent), intra operative complication (perforation and extravasation) were assessed. For statistical assessment, univariate and multivariate logistic regression analyses were used.

Result: The mean±SD of patient's age was 37.5±14.7 years, ranged from 5 to 75 years. The highest age group was 15-49 years i.e 71%. Male (62.5%) was more common than female (37.5%). Body Mass Index (BMI) was calculated for patients and the results were: under weight (4.5%), normal weight (31.5%), over weight (41.0%) and obese (23%). The overall blood transfusion rate was 14%. One patient (0.5%) underwent angioembolization after surgery. The average blood loss was 1.5±1g/dl. Multivariate stepwise regression analyses showed that the most important factors affecting the rate of blood transfusion were: the intraoperative complication (perforation and extravasation), stone complexity (GUY 's Stone Scoring System), operative time (>83 minute) and the most important factors affecting the total Haemoglobin drop were Stone complexity (GUY's SSS) and preoperative creatinine level(≥1.4mg/dl.). No correlation between (age, sex, BMI, diabetes mellitus, hypertention, previous renal surgery, SWL, degree of hydronephrosis, size of amplatz, and stentting method) and rate of blood transfusion was found.

Conclusion: Our results, showed that;

I. Stone complexity (GUY's SSS, grade 3 and 4).

II. Preoperative creatinine level (≥1.4mg/dl).

III. Intra operative complication (perforation and extravasation).

IV. Duration of operation (>83 minute).

Were the most important factors associated with an increased risk of bleeding and transfusion during PNL in both univariate and multivariate analysis.

Keywords: PNL, bleeding, blood transfusion, guys scoring system, angioembolization, complication

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Abbreviations: BMI, body mass index; GUY's SSS, GUY's stone score system; S-ReSc scoring, seoul national university renal stone complexity; IRIS, retrograde intra renalsurgery; SWL, extracorporeal shock wave lithotripsy; PNL, percutaneous nephrolithotomy

Introduction

Since the invention of percutaneous nephrolithotomy (PNL) as a novel strategy in the treatment of urinary stones, both indication and technique have continued to be developed.[1,2] Despite the possibility of high-quality imaging, technical improvements of lithotripsy devices, and anesthesia tailored for each patient, PNL is still a challenging procedure that requires an experienced and careful surgeon who is aware of the pitfalls.[3] About 50% of recurrent stone formers have just one lifetime recurrence. Highly recurrent disease is observed in slightly more than 10% of patients. Stone type and disease severity determine low or high risk of recurrence.[4–6] Currently, no standardized method is available to predict success rate after percutaneous Nephrolithotomy.[7] There is several scoring system which can predict success rate and complication like: Seoul National University Renal Stone Complexity Score (S-ReSC Scoring),[7] the GUY' S Stone Score (GSS) System[8] Table 1 the GUY's stone score. Grading the complexity of percutaneous nephrolithotomy and S.T.O.N.E. Nephrolithometry Scoring System.[9]

PNL is a safe and efficient treatment option for larger stones and staghorn calculi. Nevertheless, surgeons have to face specific complications during and after the procedure.[10] Recent publications adopted the surgical Clavien classification as a comparable demonstration of complications.[11,12] Table 1 & Table 2 grading of Postoperative Complications of Percutaneous Nephrolithotomy According to the Modified Clavien Classification System. Acute hemorrhage is the most common significant complication of percutaneous access into the upper urinary tract collecting system. Percutaneous nephrostomy alone results in hemorrhage requiring transfusion in 0.5% to 4% of procedures.[13] With the addition of percutaneous nephrolithotomy, likely the percutaneous tract and increased intra renal manipulation, the incidence of hemorrhage to the point of transfusion rises to 6% to 20%.[14]

Table 1 The GUY's stone score. Grading the complexity of percutaneous nephrolithotomy[8]

Grade	Stone burden
Grade 1	-Solitary stone in mid/lower pole
	-Solitary stone in pelvis with simple anatomy
Grade 2	-Solitary stone in upper pole
	-Multiple stone in patient with simple anatomy
	-Solitary stone in patient with abnormal anatomy
Grade 3	-Multiple stones in patient with abnormal anatomy
	-Stones in caliceal diverticulum
	-Partial staghorn calculus.
Grade 4	-Staghorn calculus
	-Any stone in a patient with spina bifida or spinal injury

Table 2 Preoperative findings in the studied population

Preoperative findings	Number	Percent
Diabetes mellitus	23	11.5
Hypertension	39	19.5
Serum creatinine (>1.4)	4	2
Previous renal surgery	73	36.5
Stone location		
· Pelvic	53	26.5
· Upper pole	8	4
· Lower	38	19
· Mid	14	7
· Staghorn	26	13
· Partial	2	1
Previous SWL	75	37.5
Previous renal surgery	73	36.5
Renal anomaly	19	9.5

Factors associated with hemorrhage during percutaneous surgery include patient characteristics, multiple access sites, supracostal access, increasing tract size, tract dilation with methods other than balloon dilation, prolonged operative time, and renal pelvic perforation, inexperience, preoperative anemia.[15,16] Blood transfusion was classified as a Clavien class II complication, radiological embolisation under local anaesthesia as IIIa and ICU admission or life-threatening complication as a class IV.[17] Definition of blood transfusion should include the time and number of units of blood transfused. Only transfusion with indication related to surgical procedure should be reported. The cut-off level use to make decision to transfuse should be reported.[18] Aim of the study although percutaneous nephrolithotomy (PNL) has been accepted as a standard method for the management of large renal stones, the incidence of renal hemorrhage is relatively high. This study investigated the variables that affect Haemoglobin drop and blood transfusion during PNL.

Materials and methods

Between (Feb/2014) to (Oct/2015) the demographic and procedural data of 200 patient (125 male and75 female) who underwent PNL (106 right side, 94 left side), were maintained prospectively and analyzed regarding the factors which may have potential impact on haemoglobin drop and blood transfusion. Patients were divided depending on their ages in to those <15 years, 15-49 years and >50. Informed consent was obtained from patients before operation. The entire procedure was performed in the Urology department with the patient under general anaesthesia (171 patients) or spinal anesthesia (29 patient). The number and types of access depended on the size of treated stones (staghorn stone versus single stone) and localization (upper or lower pole) At the end of procedure, a clamped Foley catheter placed as a nephrostomy tube and opened after 8 hours. JJ stent placed for most of the subjects (159 patients) and removed after weeks. Ureteric stent left in place (41 patients) for those without JJ stent and removed after 24 to 48 hours. In this study, Hb checked preoperatively for all patients and repeated 24 hours following PNL. If necessary Hb checks were performed at more frequent intervals for specific cases. Urine output, haematuria, vital signs (pulse rate, blood pressure) routinely followed after operation. The urethral catheter was removed after 24-48 hours and nephrostomy tube was removed after 2-6 days. Stone burden and location classified based on GUY's stone scoring system, It comprises 4 grades (Table 1).

Changes in haemoglobin concentration is defined at the difference between preoperative and24 hour postoperative haemoglobin concentrations, and prior to discharge and patients receiving blood transfusion were identified. It was considered that a 1 unit blood transfusion increase the hemoglobin level by 1 gram/dl and hematocrite by 3%. Therefore drops in hemoglobin and hematorcirite were calculated as following: (Preoperative Hb(Hct)-postoperative Hb(Hct)) –(number of unit transfused *1 gram/dl (3% Hct). A proposed definition for blood transfusion; the total number of whole blood units transfused in the perioperative stay with the cut-off 10gram/dl. Postoperatively, patients with Hb <10 g/dl were transfused. Patients with Hb >10 g/dl but clinically showed symptoms of anaemia underwent further follow up, those who persist with anaemic symptom were transfused. Patient with intractable bleeding, haematuria or hemodynamic instability were candidates for angiographic intervention.

Results and discussion

The mean±SD of patients age was 37.5±14.7 years, ranged from 5 to 75 years. The highest age group was 15-49 years i.e 71%. Male (62.5%) was more common than female (37.5%). Body Mass Index (BMI) was calculated for patients and the results were: under weight

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(4.5%), normal weight (31.5%), over weight (41.0%) and obese (23%). Table 2 demonstrate some preoperative characteristics of the studied population. The commonest stone size was 20-30 mm (42%). According to the GUY's Stone Scoring system. The highest incidence of stone complexity was grade 1 and 2 in 35% and 47.5% respectively. The average operation time was 83 minute .The duration was less than average in 60% of patients. One puncture used in most of patients 85.5%. *Haemoglobin drop* the average Hb drop after PNL procedures were 1.5±1 g=dL (median 1.3 g/dL; range 0.0–4.8 g/dL). Table 3 showed the factors affecting Hb drop assessed by unuivariate analysis. Outcome of multivariate logistic regression analysis for factors affecting total Hb drop demonstrated in Table 4.

Table 3 Factors Affecting Hb drop assessed by univariate analyses

Parameters	Hb Drop (g/dl) Mean+ SD	P Value
Age Group		0.312
- <15	1.07+0.48	
-64	1.50+1.00	
- >50	1.45+1.10	
Sex		0.439
- Male	1.50+0.99	
- Female	1.38+1.02	
BMI		0.001
- Under Weight	1.71+0.52	
- Normal	1.45+0.94	
- Over wt	1.17+0.81	
- Obese	1.92+1.26	
Diabetes Mellitus		0.024
- (-ve)	1.40+0.97	
- (+ve)	1.90+1.15	
Hypertension		0.046
- (-ve)	1.39+0.95	
- (+ve)	1.74+1.16	
Preoperative creatinine level (≥ 1.4 mg/dl)		0.003
- (-ve)	1.43+0.97	
- (+ve)	2.95+1.55	
Previous renal surgery (Pyelolathiotomy & PNL)		0.777
- (-ve)	1.44+1.07	
- (+ve)	1.48+0.86	
Renal Anomalies		0.001
- (-ve)	1.38+0.96	
- (+ve)	2.20+1.05	
Previous SWL		0.103
- (-ve)	1.37+0.94	
- (+ve)	1.61+1.07	
Stone size		0.001
- < 20mm	1.03+0.88	
- 20 -30mm	1.44+0.86	
- > 30mm	1.72+1.13	
Stone complexity (GUY's Stone scoring system)		0.017
-1	1.31+0.97	
-2	1.39+0.96	
-3	1.85+0.50	
-4	1.95+1.24	
Degree of Hydronephrosis		0.142
- No	0.88+0.65	
- Mild	1.52+0.93	
- Moderate	1.55+1.02	
- Severe	1.30+1.05	
Type of Anesthesia		0.816
- GA	1.46+0.99	
- SA	1.42+1.05	
Duration by Minute		0.003
- < 83	1.29+0.91	
- > 83	1.71+1.08	
Number of Punctures		0.581
-1	1.43+0.99	
-2	1.64+1.12	
-3	1.65+0.75	
Size of Amplatze		0.178
- Mini	0.65+0.75	
- 20 – 24Fr	1.60+1.08	
- 26 – 30 Fr	1.44+0.98	
DJ or stent		0.191
- DJ	1.50+0.98	
- Stent	1.27+1.05	
Intraoperative Complication (Perforation and Extravasation)		0.296
- (-ve)	1.42+1.03	
- (+ve)	1.63+0.81	

Table 4 Outcomes of multivariate binary logistic regression analysis: factors affecting Hb drop.

Factors	P value	Odds ratio	95% CI	
			Lower	Higher
Stone complexity (GUY's SSS)	0.039			
1		1	0.57	2.91
2		1.22	1.02	4.89
3		1.54	1.97	5.86
4		2.01		
Preoperative creatinine rise (≥1.4 mg/dl)	0.042			
Absent (Reference)		1	1.03	5.32
Present		1.96		

*Blood transfusion***,** Overall blood transfusion rate was 14% (n=28 patients). Table 5 demonstrate the factors affecting blood transfusion in univariate analysis. Table 6 shows Outcome of multivariate logistic regression analysis for blood transfusion. Blood loss frequently occurs from the nephrostomy tract itself, but can also be secondary to parenchymal lacerations incurred during tract dilation or stone breakup, or lesions of the vascular system arising from pseudo aneurysms or arteriovenous fistulae.[19] Fortunately, in most cases bleeding can be controlled with conservative measures, such as clamping the nephrostomy, hydration, and haemostatic medications.[20]

Table 5 Factors affecting blood transfusion requirement assessed by univariate analysis

Parameters	Transfusion	Transfusion	P value
	(-ve)	(+ve)	
Age Group			0.278
- <15	14(100)	0 (0)	
-64	120 (84.5)	22 (15.5)	
- >50	37 (84.1)	7 (15.9)	
Sex			0.437
- Male	105 (84)	20 (16)	
- Female	66 (88)	9 (12)	
BMI			0.727
- Under weight	7 (77.8)	2 (22.2)	
- Normal	52 (82.5)	11 (17.5)	
- Over wt	72 (87.8)	10 (12.2)	
- Obese	40 (87.0%)	6 (13.0)	
Diabetes Mellitus			0.295
- (-ve)	153 (86.4)	24 (13.6)	
- (+ve)	18 (78.3)	5 (21.7)	
Hypertension			0.74
- (-ve)	137 (85.1)	24 (14.9)	
- (+ve)	34 (87.2)	5 (12.8)	
Preoperative Creatinine Level (≥1.4)			0.042
- (-ve)	169 (86.2)	27 (13.8)	
- (+ve)	2 (50.0)	2 (50.0)	
Previous Renal Surgery			0.154
- (-ve)	112 (88.2)	15 (11.8)	
- (+ve)	59 (80.8)	14 (19.2)	
Renal Anomalies			0.004
- (-ve)	159 (87.8)	22 (12.2)	
- (+ve)	12 (63.2)	7 (36.8)	
Stone Complexity (GUY's System)			0.001
-1	65 (92.9)	5 (7.1)	
-2	83 (89.2)	10 (10.8)	
-3	10 (83.3)	2 (16.7)	
-4	13 (52.0)	12 (48.0)	
Stone Size			0.01
- < 20mm	38 (90.5)	4 (9.5)	
- 20 -30mm	77 (91.7)	7 (8.3)	
- > 30mm	56 (75.7)	18 (24.3)	
Previous SWL			0.108
- (-ve)	103 (82.4)	22 (17.6)	
- (+ve)	68 (90.7)	7 (9.3)	
Degree of Hydronephrosis			0.107
- No	8 (80.0)	2 (20.0)	
- Mild	53 (89.8)	6 (10.2)	
- Moderate	78 (88.6)	10 (11.4)	
- Severe	32 (74.4)	11 (25.6)	
Duration by Minutes			0.001
- < 83	114 (95.0)	6 (5.0)	
- > 83	57 (71.3)	23 (28.8)	
Number of punctures			0.038
-1	150 (87.7)	21 (12.3)	
-2	19 (76.0)	6 (24.0)	
-3	2 (50.0)	2 (50.0)	
Size of Amplatze			0.487
- Mini	4 (100.0)	0 (0)	
- 20 – 24Fr	34 (81.0)	8 (19.0)	
- 26 – 30 Fr	133 (86.4)	21 (13.6)	
DJ or stent			0.333
- DJ	134 (84.3)	25 (15.7)	
- Stent	37 (90.2)	4 (9.8)	
Complication (Intraoperative perforation)			0.001
- (-ve)			
- (+ve)	155 (92.3)	13 (7.7)	
	16 (50.0)	16 (50.0)	

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Table 6 Outcomes of multivariate binary logistic regression analysis: factors affecting blood transfusion requirement

Factors	P value	Odds ratio	95% CI	
			Lower	Higher
Complication	0.001			
Absent (reference)		1	1.44	7.14
Present		4.04		
Stone Complexity (GUY's scoring system)	0.004			
1 (reference)		1	0.15	2.71
2		1.17	0.372	3.89
3		1.2	1.07	4.33
4		2.8		
Duration of Anesthesia	0.001			
< 83 minutes (reference)		1	1.39	3.63
> 83 minutes		2.01		

Blood transfusion was reported in 27 studies. Twenty-one (77.8%) of the studies did not report the criteria for blood transfusion. Three (11.1%) of the studies reported a cutoff Hb level of 9 gm/dl, while one study used a cutoff level of 10g/dl. Five studies reported estimated blood loss without explanation of calculation.[18] Table 7 demonstrate comparison of transfusion rate with other published series. Excessive bleeding during PNL managed by some maneuvers, like placement of a larger nephrostomy tube, nephrostomy tube clamping, hydration, balloon tamponade and haemostatic medication. The bleeding is mainly venous in origin and most of our intraoperative bleeding was controlled conservatively. In our study, only 1 (0.5%) patient needed angiographic embolization of the bleeding renal artery. Table 8 demonstrate comparison of Embolisation rate with other published series.[21–23]

Table 7 Comparison of transfusion rates with other published series

Series	N	Transfusion rate %
Keoghane et al.[21]	547	
Unsal et al.[22]	868	3.8
de la Rosette et al.[21]	5803	9.5
Tolga et al.[23]	649	5.7
Stoller et al.[21]	127	10.8
Jones et al.[21]	1000	23
Lee et al.[21]	582	29
Current study	200	12
		14

Table 8 Demonstrate comparison of Embolization rate with other published series

Series	N	Embolization rate %
Keoghane et al.[21]	547	0.9
Martin et al.[21]	808	1
Kessaris et al.[21]	2200	0.8
Jones et al.[21]	1000	0.6
Mousavi-Bahar et al.[22]		0.15
Current Study	200	0.5

Conclusion

i. Stone complexity (GUY's SSS., grade 3 and 4).

ii. Preoperative creatinine level (≥1.4mg/dl).

iii. Intra operative complication (perforation and extravasation).

iv. Duration of operation (>83 minute).

Were the most important factors associated with an increased risk of bleeding and transfusion during PNL in both univariate and multivariate analysis. Study demonstrates several statistically significant Cutoff value such as, (Operating time >83 minute, preoperative creatinine level ≥1.4mg/dl) correlated well with Hb drop and transfusion rates.

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Conflicts of interest

The author declares there is no conflict of interest.

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