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Study of Risk Factors Associated With Hemorrhage in Percutaneous Nephrolithotomy

Bandhan Bahal, Soumendranath Mandal*, Prashant Gupta, Anshuman Aashu, Sudipta Kumar Singh, Pramod Kumar Sharma

Department of Urology, Calcutta National Medical College & Hospital, Kolkata India

***Corresponding author:** Soumendranath Mandal
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Abstract **Original Research Article**

Percutaneous nephrolithotomy (PCNL) is the first line treatment for renal stones. Hemorrhage is the most significant complication of PCNL. Purpose of this study is to analyze various risk factors associated with hemorrhage in percutaneous nephrolithotomy (PCNL). Medical records of 295 patients, who underwent PCNL between March, 2017 and February, 2019 were analyzed retrospectively. Various patient related risk factors like age, sex, body mass index, diabetes, urinary tract infection, history of previous renal surgery; stone related risk factors like, stone size and number, hydronephrosis and surgery related risk factors like surgery duration, number of tracts, tract size, pelvicalyceal perforation were assessed. Statistical analysis was done using univariate and multivariate analysis. Average drop in hemoglobin after PCNL was 1.88±1.52 g/dl. Blood transfusion was required in 20 patients (6.7%). Mean operating time was 73.71±22.54 minutes. Presence of diabetes mellitus, urinary tract infection, large stone size, multiple tracts and pelvicalyceal perforation were independent risk factors for hemorrhage. Most of the patients were managed conservatively with strict bed rest, intravenous crystalloids and antibiotics with or without blood transfusion. One patient (0.33%) was diagnosed with pseudoaneurysm on angiography. According to this study, diabetes mellitus, urinary tract infection, large stone size, multiple tracts and pelvicalyceal perforation are independent risk factors for hemorrhage. Further large prospective studies are required for assessment of risk factors for bleeding in PCNL.

Keywords: Hemorrhage, Percutaneous nephrolithtomy, Transfusion.

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) has evolved as the gold standard technique for removal of large and complex renal stones. It clearly provides an edge over other techniques like open renal surgeries and retrograde intra-renal surgeries, in the form of lower cost, better stone clearance rates (>90%) and early recovery [1]. Hemorrhagic complications seek significant attention during and after surgery [2- 4]. Prospective data, collected by the Clinical Research Office of the Endourological Society, on PCNLs performed around the world over one year period, found a 7.8% rate of significant hemorrhage and 5.4% blood transfusion rate [2]. Transfusion requirement during and after PCNL ranges between 1% and 11% [3-5]. A number of factors have been linked to the hemorrhagic complications associated with PCNL.

In order to keep hemorrhagic complications to a minimum in PCNL, a holistic approach with optimization of patient risk factors, implementing excellent surgical techniques and early identification and management of bleeding is essential. This study aims to determine various risk factors associated with hemorrhage in PCNL.

MATERIAL AND METHODS

Medical records of 295 patients, who underwent PCNL at our institute between March, 2017 and February, 2019 were reviewed. Patients who underwent ureteroscopic lithotripsy along with PCNL and patients who underwent tubeless and relook PCNL were excluded.

All PCNLs were done in prone position. Fluoroscopy guided puncture was done in all the patients. One step tract dilatation technique was used. Tract was dilated upto 20-30 Fr, with either Amplatz dilator or Alken metallic dilator. 18 Fr rigid nephroscope was used. Stone fragmentation was done with Swiss Lithoclast Master. Double J stent was inserted in most of the patients, except in patients with small stone burden, minimal bleeding and complete stone clearance. Nephrostomy tube was inserted in all

the patients for simultaneous drainage and hemostasis. Significant bleeding, which obscured vision was controlled by moving the sheath closer to the calculus or pelvicalyceal system wall. If bleeding persisted, the tract was occluded with sterile gauze or a large diameter councill tip catheter. Catheter balloon was inflated with 3 ml normal saline. Bleeding was reassessed after 5 minutes of tamponade. Procedure was terminated at this point of time if significant bleeding persisted. A large bore nephrostomy tube was placed for hemostasis and to facilitate stone access for later re-entry.

Significant hemorrhage was identified by the requirement of either blood transfusion, prolonged admission due to hematuria or nephrostomy site bleeding and requirement of readmission due to bleeding. These patients constituted group A. All the other patients formed group B.

We assessed various patient related risk factors like age, sex, body mass index, history of diabetes mellitus, presence of urinary tract infection and history of any previous renal surgery; stone related risk factors like number of stones, stone size, and degree of hydronephrosis and operation related risk factors like number of tracts, tract size, duration of surgery and pelvicalyceal rupture or perforation.

All patients with significant hemorrhage in postoperative period were managed with strict bed rest, hemodynamic monitoring and intravenous crystalloids with or without blood transfusion.

Postoperative significant tract site bleeding was controlled by placing a 3 liter normal saline bag underneath the nephrostomy site and placing patients' ipsilateral arm over the abdomen. Hematuria was managed with urinary bladder wash. If repeated clot retention occurred, patients underwent cystoscopy and clot evacuation. Patients requiring repeated blood transfusion, repeated cystoscopy and hemodynamic instability underwent CT-angiography.

The collected data was analyzed using Statistical Package for the Social Sciences (IBM SPSS® statistics version 25) computer program. Univariate analysis was done for all the variables.

The variables which had significant impact in univariate analysis were further evaluated with binary logistic regression multivariate analysis model. p value of < 0.05 was considered to be statistically significant.

RESULTS

295 patients were included in this study (184 males and 111 females). Mean age was 34.5 years (range-15 to 65 years). Mean operation time was 73.7 minutes (range- 30 minutes to 145 minutes).

Average hemoglobin drop after surgery was 1.88±1.52 gm/dl (range- 0.3-4.6 g/dl). 20 patients required postoperative blood transfusion (6.7%). 2 patients required prolonged admission for hemorrhage (0.67%). 2 patients required readmission for hemorrhage (0.67%). Postoperative bleeding mostly occurred within 5 days of surgery. 14 patients required cystoscopy and bladder clot evacuation. One patient (0.33%) was readmitted with gross hematuria and diagnosed to have pseudoaneurysm.

Amongst patient related risk factors, age, sex and body mass index did not have significant association with hemorrhage. However patients with diabetes mellitus had significantly higher chances of hemorrhage (p value <0.001). Similarly, presence of urinary tract infection was significantly associated with bleeding (p value <0.001). Rate of bleeding was significantly higher in patients with history of renal surgery (p value- 0.035).

Amongst stone related risk factors, large stones (p value- 0.001) and absence of hydronephrosis (p value- <0.001) were associated with bleeding.

Amongst surgery related risk factors, hemorrhage was strongly associated with longer operative time (p value- 0.005), multiple tracts (p value <0.001), larger tracts (p value <0.001) and presence of pelvicalyceal perforation (p value <0.001) (Table 1).

Table-1: Risk factors for hemorrhage assessed with univariate analysis

(A) Patient related factors			
Factors	Group An n (%)	Group B n (%)	p value
Age in years[(a)]			
15-49	18 (8.3)	201 (91.7)	0.879
>50	6 (7.9)	70 (92.1)	
Sex[(b)]			
Male	16 (86.9)	168 (13.1)	0.651
Female	8 (7.2)	103 (92.8)	
BMI*[(c)] kg/m^2			
<18.5	3 (7.1)	39 (92.9)	
18.6-24.9	6 (6.4)	87 (93.6)	0.081
25-29.9	12 (9.9)	109 (90.1)	
>30	3 (4.3)	66 (95.7)	
Diabetes[(b)]			

Yes	10 (29.5)	24 (70.5)	<0.001
No	14 (5.3)	247 (94.7)	
UTI** (b)			
Yes	14 (23.4)	46 (76.6)	<0.001
No	10 (4.2)	225 (95.8)	
Previous open surgery(b)			
Yes	7 (16.2)	36 (83.8)	
No	17 (6.7)	235 (93.3)	0.035
(B) Stone related risk factors			
Stone size (mm)(c)			
<20	2 (3.1)	61 (96.9)	
20-30	5 (4.0)	119 (96.0)	0.001
>30	17 (15.8)	91 (84.2)	
Hydronephrosis(c)			
No	6 (40)	9 (60)	
Mild	6 (6.8)	81 (93.2)	<0.001
Moderate	8 (6.1)	122 (93.9)	
Severe	4 (6.3)	59 (93.7)	
(C) Surgery related risk factors			
Duration of surgery(a)			
<80 minutes	7 (3.9)	171 (96.1)	0.005
>80 minutes	17 (14.5)	100 (85.5)	
Number of tracts(c)			
1	12 (4.7)	240 (95.3)	
2	9 (24.3)	28 (75.7)	<0.001
3	3 (50)	3 (50)	
Tract size(a)			
20-24 Fr	15 (5.8)	241 (94.2)	<0.001
26-30 Fr	9 (23.1)	30 (76.9)	
Pelvicalyceal perforation(b)			
Yes	15 (31.9)	32 (68.1)	<0.001
No	9 (3.6)	239 (4.4)	

*- Body Mass Index
**- Urinary Tract Infection
(a)- Mann-Whitney U test
(b)- Chi-square test
(c)-Kruskal-Wallis H test

Amongst all the significant variables in univariate analysis, presence of diabetes mellitus, urinary tract infection, stone size, multiple tracts and pelvicalyceal perforation maintained their significance in multivariate analysis (Table 2).

Table-2: Multivariate binary logistic regression analysis for factors affecting hemorrhage

Risk Factors	Odds Ratio	95% Confidence interval	p value
Diabetes:			
No (reference)	1	1.177-10.033	0.026
Yes	3.916		
UTI:			
No (reference)	1	1.570-5.827	0.005
Yes	4.310		
Stone size (mm):			
<20 (reference)	1		
20-30	1.231	2.386-9.673	0.007
>30	2.211		
Tracts			
1 (reference)	1	1.604-10.438	0.005
2	1.34		
3	4.494		
Pelvicalyceal perforation			
No (reference)			
Yes	1	2.397-22.417	<0.001
	7.330		

DISCUSSION

According to American association of urology and European association of urology, PCNL is the first line treatment for renal stones [6]. Hemorrhage is the most significant complication of PCNL [1]. So far, a standard classification system for hemorrhage has not been proposed. The presentation may be early or delayed and ranges from mild to severe bleeding [7-9].

According to Huang *et al*. repeated urinary tract infections lead to chronically inflamed tissue, which bleed easily [10]. Also, infections impair effective blood clotting. In our study, urinary tract infection was significantly associated with hemorrhage. Yesil *et al*. analyzed the effect of previous renal interventions on bleeding and found that prior open surgery was significantly associated with hemorrhage compared to prior ESWL or PCNL [11]. On the contrary, Resorlu *et al*. found no significant difference in hemorrhage in patients treated with prior ESWL or open renal surgery [12]. Kukreja *et al.* found a significant decrease in bleeding in patients with a prior history of PCNL or open surgery [13]. We found previous renal surgery as a significant risk factor for hemorrhage in univariate analysis, however not as an independent risk factor in multivariate analysis. Diabetes mellitus causes arteriosclerosis and microangiopathies, which lead to bleeding after initial trauma [14]. We found diabetes mellitus as an independent predictive factor for hemorrhage, as assessed by multivariate analysis.

On univariate analysis, we found stone related risk factors like large stone size and absence of hydronephrosis to be significantly associated with hemorrhage. However, in multivariate analysis, only stone size was significantly associated with bleeding. Srivastava at el. found that stone size was the only predictive factor associated with bleeding [15]. This association may be linked to increase in number of maneuvers necessary for stone clearance in large staghorn stones. Also, use of rigid nephroscope to reach distant calyces causes injury to renal parenchyma and calyceal neck. Use of flexible nephroscope may limit these injuries. Said SHA *et al*. found that absence of hydronephrosis had a significant impact on hemorrhage [16]. We found similar significant impact of absence of hydronephrosis in univariate analysis, but eventually not in multivariate analysis.

Hemorrhage is related to use of multiple tracts. Kukreja and associates found an average blood loss of 2.36±1.3 g/dl and a transfusion rate of 16.6% in patients requiring multiple tracts [13]. These corresponding parameters, however, were 1.4±1.0 g/dl and 4.6% for a single access, respectively ($P < 0.0001$). We found multiple tracts independently increase risk of hemorrhage. Akman *et al*. found that complex stones, surgeons' inexperience, large stones and multiple accesses increase the operating time, which result in complications like hemorrhage [14]. Surgery duration in excess of 110-120 minutes has been associated with increased bleeding [17, 18]. Some centers terminate the procedure after a set duration of time (2-3 hours), and stage the procedure thereafter if required. In univariate analysis, we found surgery duration of more than 80 minutes to be significantly linked with bleeding. Infundibular tear may occur during tract dilatation or calculus manipulation [13]. These tears may be associated with laceration of infundibular vessels. Subsequent manipulations will further increase the laceration, leading to bleeding. We found pelvicalyceal tear to have a significant independent impact on bleeding in PCNL.

Keoghane *et al*. found that bleeding from an arteriovenous fistula or pseudoaneurysm requiring selective angiographic embolization occured in less than 1% of patients [3]. In our study, one patient (0.33%) presented with delayed hematuria. Patient received 3 units of whole blood transfusion and repeated bladder wash. Patient was found to have pseudoaneurysm on angiography.

Our study has several limitations. This is a retrospective study, with a small patient population. We used single step tract dilatation technique with either Amplatz dilator or Alken metallic dilator in all the patients. We did not compare the impact of type of dilators on bleeding; moreover we could not compare single step tract dilataion technique with serial tract dilatation technique. Gonen and associates compared balloon dilatation with Amplatz dilatation and found no difference in bleeding between both the groups [19]. Kukreja and colleagues found that balloon and Amplatz dilators were associated with lesser blood loss as compared to Alken metallic dilator [13]. Present study lack data on type of nephroscopes and lithotripters. Akman and colleagues found that flexible nephroscopes were associated with lesser blood loss when compared with rigid nephroscopes, but flexible nephroscopes were difficult to handle and provided poorer vision [14]. Lehman and associates compared combination of pneumatic and ultrasonic lithoclasts with ultrasonic lithoclasts alone and found no significant difference in blood loss between two groups [20]. We missed surgeons' experience in predicting hemorrhage in PCNL. Allen and associates suggested 60 PCNL procedures for surgical competence and 115 procedures for excellence [21].

CONCLUSION

Depending on the result of this study, diabetes mellitus, urinary tract infection, large stone size, multiple tracts and presence of pelvicalyceal perforation are independent risk factors for bleeding associated with PCNL. However, further prospective randomized controlled studies are recommended.

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