ORIGINAL RESEARCH

Analysis of Risk Factors of Complications in Percutaneous Nephrolithotomy at the East Avenue Medical Center

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Objective: This study evaluated postoperative complications of percutaneous nephrolithotomy (PCNL) and the influence of selected factors on the risk of complications using the modified Clavien classification system in East Avenue Medical Center.
Patients and Methods: All patients who were treated with Percutaneous Nephrolithotomy (PCNL) at East Avenue Medical Center from January to August 2017 were included. Complications were evaluated by the modified Clavien classification system.
Results: Of the 45 patients with Clavien scores, 5 (11.1%) patients experienced one or more complications. Noted complications were fever, pneumothorax, hydrothorax and sepsis. According to the modified Clavien classification, the majority had no complications and classified as Clavien grade 0.
Conclusion: The majority of complications after PCNL are minimal. Longer operative time and age > 59 are associated with the risk of more severe postoperative complications in PCNL.

Keywords: percutaneous nephrolithotomy

Introduction

Since it was proposed nearly 20 years ago,[1] the Clavien classification system in which complications of surgery are systematically graded has been used widely in the hospital setting to assess the complications of a broad range of surgeries. This system was reevaluated and modified in 2004 to increase its accuracy and applicability across surgical procedures.[2-4] In urological settings, the modified Clavien classification system has been used to grade perioperative complications after endoscopic extraperitoneal, laparoscopic transperitoneal, and open radical prostatectomy,[5-9] laparoscopic live donor nephrectomy,[10] and other urologic laparoscopic procedures.[11]

Recent studies have extended the use of the modified Clavien classification system to the assessment of outcomes of percutaneous nephrolithotomy (PCNL).[12-14]

Percutaneous Nephrolithotomy (PCNL) as a primary treatment for patients with renal stones has been resurgent during the last decade, leading to an increase in variations of the technique.[15] In light of this, the Clinical Research Office of the Endourological Society (CROES) has conducted a prospective observational study of consecutive patients who were treated with PCNL at centers around the world over 1 year which was the basis of this study.[16] The purpose of the CROES PCNL Global Study was to establish a prospective global database for the current indications and outcomes of PCNL. The present analysis of the database

examined the postoperative complications of the PCNL procedures using the modified Clavien classification system and the influence of selected risk factors on the risk of complications in East Avenue Medical Center.

The objectives of this analysis were: to identify the common complications of PCNL done in East Avenue Medical Center; to identify risk factors for the development of postoperative morbidity after PCNL and to explore the possible development of a prediction model of Clavien score based on identified risk factors using multivariate analysis.

Patients and Methods

The CROES PCNL Global Study was a prospective observational study during which data were collected for consecutive patients who were treated at each participating center over a 1-year period became the basis of this study. The study organization and methods were described previously.[16] Perioperative complications were assessed and scored according to the modified Clavien classification system[2] as applied to PCNL13 (Table 1).

The authors gathered 45 patients who were divided into 16 private cases and 29 charity cases, who underwent PCNL from January to August 2017 in East Avenue Medical Center. Data were then gathered retrospectively and each patient was classified using the modified Clavien scoring system.

Analytical and Statistical Methods

In this analysis, the Clavien classification system was treated as an ordinal scale with values from 1 to 8, as follows: 1, Clavien grade 0 (no complications); 2, Clavien grade I; 3, Clavien grade II; 4, Clavien grade IIIa; 5, Clavien grade IIIb; 6, Clavien grade IVa; 7, Clavien grade IVb; and 8, Clavien grade V (death during the postoperative period). Since more than 50% of patients had no complications, for comparative and statistical analyses, 1 was used as the reference point of the ordinal scale and the differences between each level in the scale were assumed to be equivalent.

Table 1. Grading of postoperative complications of percutaneous nephrolithotomy according to the modified Clavien classification system[2]

Complication Grading	Description
0	No complications
I	Deviation from the normal postoperative course without the need for intervention,
II	Minor complications requiring pharmacological intervention, including blood transfusion and total parenteral nutrition
IIIa	Complications requiring surgical, endoscopic or radiological intervention, but self limited, without general anesthesia
IIIb	Complications requiring surgical, endoscopic radiological intervention, but self-limited, with general anesthesia
IVa	Life threatening complications requiring intensive care unit management; single organ dysfunction, including dialysis
IVb	Life threatening complications requiring intensive care unit management; multiorgan dysfunction
V	Death resulting from complications

An example of the calculation performed is as follows. Assuming the mean Clavien score for patients with cardiovascular disease (CVD) was 1.48 while for those without CVD, it was 1.33. This gives an absolute difference in the mean Clavien score of 0.15; the relative increase in Clavien score from the presence of CVD was therefore 11.2%; ie, 0.15/1.33 · 100%.

Based on published literature, the relationship between Clavien score and the following patient characteristics and operative factors was analyzed: age, sex, weight category, ASA physical status classification score, CVD status, diabetes status, anticoagulant use, urine microbiologic culture, stone load and operative time. Patients were assigned to groups according to these variables. The mean Clavien score for each group and the intergroup difference in mean Clavien scores were calculated.

For patients with non-staghorn calculi, renal stone load was calculated by aggregating the estimated volume of each stone using the formula: Total stone load = (L x W x P x 0.5).[17] Patients were assigned according to their calculated total stone load to groups with low (up to and including the median stone burden of 353mm^3) or high (above 353 mm^3) stone burden.

For multivariate logistic regression analysis, the Clavien scores were grouped into minor complications (Clavien grades I and II) and major complications (Clavien grades III and IV), as previously defined.[18] The interaction of the selected variables with minor and major complications was then analyzed by standard regression analysis methods.

Results

Retrospective data were obtained from 45 patients at the East Avenue Medical Center from January to August 2017. Based on their Clavien scores, 5 of 45 patients (11.1%) experienced one or more complications.

Postoperative Complications

Noted complications were fever (2) pneumothorax (1) hydrothorax (1) and sepsis (1). According to the modified Clavien classification, the majority had no complications classified as Clavien grade 0 (Figure 1).

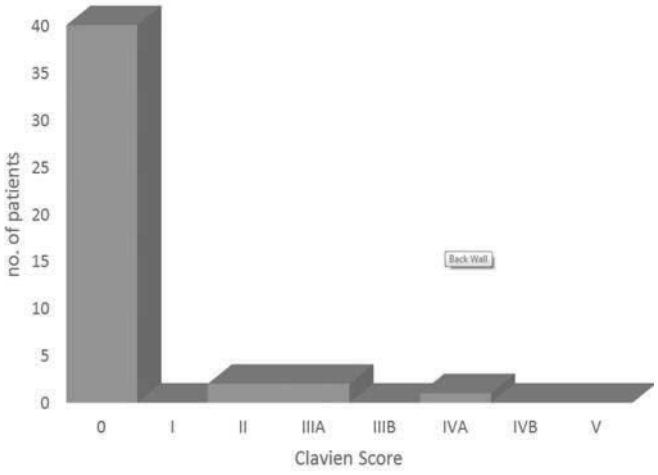

Figure 1. Distribution of modified Clavien grading scores.

Relationship between Clavien Score and Risk Factors

The mean Clavien scores for selected patient and procedural characteristics are shown in Table 2. The skewed distribution of the Clavien scores in all patients with complications, as shown in Figure 2, also occurred in the distribution of scores in each risk factor subgroup. The factors associated with the largest absolute increases in mean Clavien score were: use of anticoagulants (0.93), urine cultures (0.93), renal stone burden (0.64), diabetes mellitus (0.48) and cardiovascular disease (0.51). For comparison, the relative increases in mean Clavien score were: ASA physical status classification had no or a negligible impact since all patients were classified as ASA 1 respectively, presence of concurrent CVD (47%), diabetes mellitus (56%), renal stone burden (20%) and sex (19%) in favor to the male. Age ranges < 19 years and 40 to 59 years (relative to age 19-< 40 years), and being overweight or obese had no or a negligible impact on mean grading score. All other selected risk factors did not affect the mean grading score.

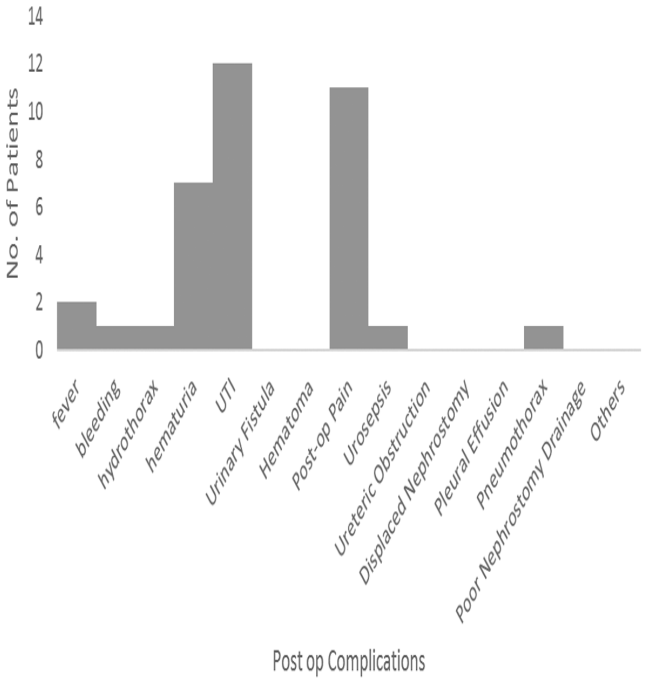

Figure 2. Number of complications occurring in post operative patients.

Table 2. Comparison of mean Clavien scoring for selected patient and operative characteristics.

Factor	n	Mean Clavian	SD Score
Total operative time	45	0.93	1.323
Short (≤ 50 min)	8	1	0
Medium (51-75 min)	24	1	0
Long (76-115 min)	9	0.66	1.32
Very long (≥ 116 min)	4	3.5	2.51
Sex			
male	27	0.51	1.28
female	18	0.33	1.41
difference in mean score		0.18	
Age			
<19 years	0	0	0
19- < 40 years	11	1	0
40-59 years	18	1	0
> 59 years	16	1.25	2.01
Body Weight (BMI)			
Underweight (<18)	2	1	0
Normal Weight (18-24)	42	0.47	1.36
Overweight (25-29)	1	1	0
Obese (>30)	0	0	0
ASA physical status classification			
I	45	0.93	1.32
II	0	0	0
III	0	0	0
IV	0	0	0
Cardiovascular Disease			
Present	6	1	0
Absent	39	0.51	1.41
Difference in mean score		0.49	
Diabetes Mellitus			
Absent	41	0.48	1.38
Present	4	1	0
Difference in mean score		0.52	
Anticoagulant Medication			
used	0	0	0
not used	45	0.93	1.32
Difference in mean score		0.93	
Urine Cultures			
Negative	45	0.93	1.32
Positive	0	0	0
Difference in mean score		0.93	
Renal Stone Burden			
< 353 mm^3	14	1	0
> 353 mm^3	31	0.64	1.56
Difference in mean score		0.36	

Multivariate Regression Analysis of Potential Predictors of Clavien Score

Multivariate regression analysis of the selected patient and procedural characteristics revealed that operative time and age > 59 were significant predictors of higher mean Clavien scores (Table 3). The odds of having a major complication (Clavien IIIA and above) increased as the operative time of the patients increased; patients with an operative time lasting between 51 and 75 minutes had the lowest odds of postoperative complications. The odds of a major complication increases in tandem with an increase in the age > 59. The following covariates were not associated with increased risk of major or severe complications: CVD, diabetes mellitus, case volume, body weight, and age categories.

Table 3. Multivariate analyses of factors associated with higher risk of postoperative complications.

Covariates	Odds Ratio	p Value
Operative time (medium: 51-75 min)	0.75	0.209
Operative time (very long: ‡ 116 min)	1.62	0.024[a]
Operative time (long: 76-115 min)	2.03	0.001[a]
Age 19- < 40 years	1.07	0.228
Age 40-59 years	2.12	0.106
Age > 59 years	3.04	0.001[a]

[a]Statistically significant at $p < 0.05$

Discussion

The CROES PCNL Global Study is the largest database of patients who were treated with PCNL and proved helpful in establishing data for this study.[16] The results were collected from patients with a variety of indications for PCNL here in East Avenue Medical Center, and thus reflect the need for routine clinical use of this technique. Consistent with previous studies, it showed that while complications after PCNL are common, and most, such as bleeding or fever, are medically controllable through good clinical surveillance.[19] Major complications, such as septicemia, renal hemorrhage necessitating intervention, pleural injury, and colonic injury, are rare. In this study,

approximately more than 80% of all complications were minor, and less than 20% were major. This emphasizes the importance of grading perioperative complications according to their severity and reinforces the need for a reliable and easy-to-use system for classifying and recording complications.

In the current analysis, the authors used the absolute difference in mean Clavien score as a proxy for the impact of each risk factor. Thus, a risk factor that is associated with a larger absolute change in mean Clavien score has more impact on actual Clavien scores, and thus a greater increase in risk of postoperative complications. Conversely, variables that impart a lower mean difference in mean Clavien score have less impact on the actual grading score and are less likely to increase the risk of complications. Using this approach, five risk factors identified were associated with a marked increase in mean Clavien score and thus represent risk factors for increased likelihood of postoperative complications: Use of anticoagulants, positive urine cultures, renal stone burden, diabetes mellitus and cardiovascular disease.

Given the frequency of postoperative bleeding after PCNL, identification of anticoagulant medication use as a predictor of postoperative complications is not surprising. Use of this procedure in patients who are receiving long-term anticoagulant therapy poses a clinical dilemma. Current clinical experience suggests that PCNL can be performed on these high-risk patients with adequately planned cessation of anti- coagulant therapy; eg, from 10 days preoperatively to 5 days postoperatively. Patients should be informed of the increased risks of thromboembolic events and postoperative hemorrhagic complications.[23,24] A positive microbiologic culture from urine is also not unexpected as a risk factor for postoperative complications. Although patients with fever post-PCNL are more likely to have a positive urine culture,[25] stone culture and pelvic urine culture may be more useful than preoperative bladder urine culture,[26,27] which often fails to identify stone-colonizing pathogens.[28]

The presence of comorbidities, such as renal insufficiency, diabetes, morbid obesity, and pulmonary or CVD, has been reported to increase the risk of complications during or after PCNL.[19] Major complications after PCNL have been reported to be at least 2.5 times more common in patients with diabetes mellitus.[29] Similarly, while it is accepted that obesity generally places surgical patients at greater risk of complications, several studies including the present indicate that complication rates after PCNL in obese patients are similar to those in non-obese patients[30] and are independent of body mass index.[31,32]

Patients whose operations lasted longer than 75 minutes (76-115 minutes) had statistically significant more severe postoperative complications compared with those whose operative time was shorter than 50 minutes. The risk of more severe postoperative complications increased even further for those whose operative times were more than 115 minutes. The difference in the risk for more severe postoperative complications between those patients who had 50 minutes or less and those whose operative times were between 51 and 75 minutes was not statistically significant.

Studies on the surgical management of urolithiasis have tended to focus on radiologic outcomes, and published clinical trials contain significant deficiencies in reporting adverse events outcomes.[33] This study suggests that further analysis of the risk factors that affect PCNL outcome is needed. Postoperative complications directly impact patient quality of life, but there is currently no disease-specific quality of life instrument.[34] Refinement of the modified Clavien classification system, as suggested elsewhere,[6,14,13] perhaps with incorporation of validated risk factors, would support better targeting of PCNL.

Conclusion

Further analysis of the risk factors that affect PCNL outcome and refinement of the modified Clavien classification system are needed to enable better identification of patients at increased risk of complications after PCNL. Other factors which may contribute to PCNL complications include the choice of access site, upper vs. lower, laterality (right vs left) stone configuration or volume (based on the Guy Stone score), stone durility (hardness

based on HU) surgeon expertise (resident vs. postgraduate urologist).

The development of a disease-specific tool to predict risk of postoperative complications would help improve further the already low major complication rates of this important urologic technique.

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