

# Charlson Comorbidity Index can be a Predictor of Post-Operative Complications and Hospital Stay by Using Clavien-Dindo Classification of Patients Undergoing Per-Cutaneous Nephrolithotomy

Anil Kumar Utraadi\*, Sharjeel Saulat, Jahanzeb Sheikh, Umber Rasheed, Ashba Mushtaque, Muhammad Osama

*Department of Urology, Tabba Kidney Institute, Karachi, Pakistan.*

**Abstract: Background:** The post-operative complications after PCNL are comparatively higher in patients with comorbidities such as old age, recurrent renal stones, multiple stones, stone location and composition.

**Objective:** The purpose of this study is to evaluate the efficacy of Charlson comorbidity index to predict the post-operative complications and hospital stay of elderly patients by using Clavien Dindo classification under-going PCNL.

**Materials and Methods:** This is a prospective follow-up study, conducted from January 2023 to October 2023, at urology department of Tabba Kidney Institute. Patient aged  $\geq 50$  years, both genders diagnosed with Single or multiple, unilateral or bilateral renal stones and, solitary kidney were included in the study. CCI and Clavien Dindo classifications were documented and analyzed for associated and independent results. SPSS 22 was used to analyze the data.

**Result:** Total 152 participants were recruited in the study. The mean age of study population was  $53.5 \pm 14.2$  years, with range of 38 years. Stone clearance was reported as 97% with 147(96.7%) complete stone free cases and 5(3.2%) cases with confirmed residual stones requiring METs to achieve complete clearance. Correlation of CCI and Clavien Dindo classification identified that there is a direct association with higher grading of both classification with post-operative complications. Assessment of odds of outcome were higher in Grade III Clavien Dindo with 1.48 indicating positive odds of complications and CCI higher grading.

**Conclusion:** Charlson Comorbidity Index is a swift, simple, and reproducible scoring system to properly calculate the morbidity and mortality after PCNL.

**Keywords:** Charlson comorbidity score (CCI), Clavien Dindo classification, PCNL, Post-operative complications, Population, Patient.

## INTRODUCTION

Renal stone incidents are rapidly increasing in Pakistan and neighboring countries, demanding for precise, reasonable and appropriate management options [1]. Renal stones management options varies according to several associated factors, such as small stones ( $<0.7$ cm) present in renal pelvis or upper calyx are often managed with the help of non-invasive laser techniques such as Extracorporeal shockwave lithotripsy while same size renal stone residing in ureter may need medical expulsive therapy (METs) or Ureteroscopy (URS) [2, 3]. Percutaneous nephrolithotomy (PCNL) has major role in the management of large and complicated renal stones ( $>2$ cm) [3]. Minimal incision and bleeding through wound, lower chances of infection and early recovery are beneficial outcomes of PCNL. However, post-op complications are not negligible, including injury to pleura and vasculature, excessive bleeding, conversion to open pyelolithotomy and, long operated time due to difficult anatomy [4]. The post-operative complications are comparatively higher in patients with comorbidities such as old age, recurrent renal stones, multiple stones, stone location and composition etc. [5].

To minimize the probabilities of post-operative complications many pre-operative scores are designed to predict the outcome of procedure [5]. European Association of Urology (EAU) recommended Clavien Dindo classification of surgical complications as predicting tool for urological procedures from 1999-2010, to identify complications [6]. Charlson Comorbidity Index (CCI) is considered as a useful tool to identify comorbidities status and predicting 1-year mortality risk [7]. Accounting for age as independent predictor of mortality along with other associated factors. In healthcare settings, including primary care, outreach, the CCI is practical, Systems for collecting data and keeping electronic medical records can incorporate the CCI [8]. Validated through several studies, both the score Clavien Dindo classification and Charlson comorbidity index are identified as good tools to predict post-operative complications and mortality [7, 8]. The purpose of this single center study is to evaluate and assess the efficacy of Charlson comorbidity index to predict the post-operative complications and hospital stay of elderly patients by using Clavien Dindo classification under-going PCNL.

## MATERIALS AND METHODS

This is a prospective, cross-sectional study, conducted at urology department of Tabba Kidney Institute, from January 2023 to

\* Address correspondence to this author at the Department of Urology, Tabba Kidney Institute, Karachi, Pakistan. Email: anilkumarutraadi@yahoo.com

October 2023. Research was studied and approved by institutional review board of ethics and after obtaining ethical approval, (TKI-HEC 030), patients with confirmed diagnosis of renal calculi by radiological investigations (Ultrasound and/or CT) were requested to enroll in the study. An informed consent in the language of understanding was signed before recruitment in study. Patient aged  $\geq 50$  years, both genders diagnosed with Single or multiple, unilateral or bilateral renal stones and, solitary kidney were included in the study. The comorbidities included in CCI were another factor of eligibility criteria. Sample size was calculated with the help of WHO sample size calculator, keeping total number of PCNL performed on patients aged  $\geq 50$  years during 2021-2022 as population. N=319 total cases were reported in previous year, confidence interval was 95%, margin of error was 5% and population proportion was estimated as 25%, the minimum required sample size was 152. Patients with anatomical abnormalities i.e horse shoe kidney, polycystic kidney disease were excluded from the study.

After taking informed consent, patient was requested to complete demographic details including gender, age, comorbidities and BMI was also calculated. Complete examination, radiologic investigations, stone characteristics including size and location were reported. Charlson Comorbidity Index (CCI) [9], identified comorbidities including Myocardial infarction (MI), Congestive heart failure (CHF), Peripheral vascular disease (PVD), cerebrovascular disease (CVA) asthma, Diabetes, Gastric ulcer, Dementia or Alzheimer, Rheumatic, Hypertension, Depression and warfarin contained 1 point each, while Hemiplegia, Diabetes with end organ damage, renal disease, mild liver disease, cancer and skin ulcers contained 2 points and severe liver disease had 3 points. Only HIV/AIDS and Metastasis had 6 points, accumulated score of each patient represented severity of comorbidities into three grades, mild, with CCI scores of 1-2, moderate with CCI score of 3-4 and severe with CCI score of  $\geq 5$ . On the basis of above-mentioned parameters, patients were divided into three groups, Group A containing the patients with CCI score of 0 zero, Group B containing the patients with CCI score 1 and Group C has the patients with CCI score 2-4 Group D has the patients with CCI score  $\geq 5$ . All procedure were performed by single surgeon with experience of more than two decades. Post-operatively patient assessed by using Clavien Dindo classification by dividing into standard 5 groups, the group defined as requirement of any deviation from normal postoperative course without need of pharmacological treatment were kept in Group I, requiring pharmacological treatments with Grade I complications post-operatively in Grade II, complications, which need pharmacological treatments other than Grade I and, blood transfusion are included [10]. Grade III was divided in 2 sub categories of Grade III-a had interventions without general anesthesia and Grade III-b included intervention under general anesthesia, Grade IV is life threatening complication requiring intensive care management, divided into Group IV-a with single organ dysfunction and Group IV-b with multi organ dysfunction. Grade V reported with death of a patient. Apart from CCI and CDC, all inter-operative and post-operative details, including hospital stay and readmission due to complication of following procedure were documented.

## STATISTICAL ANALYSIS

Statistical package of social sciences (SPSS) version 22 was used to enter, sort and analyze the data. After checking normality of data, continuous variables such as age, stone sizes, operative time, lithotripsy time and laboratory investigations were analyzed as mean and standard deviation. While, categorical variables were analyzed as frequency and percentages, association of variables was analyzed with the help of odds ratio test keeping 1 as positive outcome odds after exposure, while difference between two mean values was analyzed with chi-square test keeping p-value of  $<0.05$  as significant.

## RESULT

Total 152 participants were recruited in the study, with gender distribution indicating male dominance with 83 (55%) frequency and 69 (45%) females. The mean age of study population was  $53.5 \pm 14.2$  years, with range of 38 years. Basal metabolic index reported high frequency of obese patients with BMI of  $> 25$  as per Asian population criteria.

Stone characteristics reported mean stone size of  $2.8 \pm 1.3$  cm, and the laterality of the stones identified as 42(27.6%) right sided stones, 74(48.6%) left sided stones and 36(23.6%) bilateral stones in study population. 43(28.2%) stones were located in pelvis, 23(15.1%) were in lower calyx, 32(21%) were in mid calyx, 17(11.1%) were in lower calyx and 37(24.3%) were located in multiple calyces. Stones were divided into groups according to size measurements, higher frequency was reported in 2.1-3.0 cm stone size category with 52(34.2%), followed by 1.1-2.0 cm size category with 47(30.9%) and,  $\leq 1.0$  cm stones were reported in 17(11.1%) patients, while only 15(9.8%) patients had  $\geq 4.1$  cm stone.

Charlson comorbidity index (CCI) categories reported as 52(35.2%) in group 1, 36(27.1%) and 36(27.1%) in group 2 and 3 respectively, while 28(10%) in group 4.

The presentation of study population in Clavien Dindo classification reported 119(78.2%) as Grade I, 30(19.7%) in Grade II and 3(1.9%) in Grade III. While Grade IV and Grade V had no patients from study. Grade III patients has post-operative complications with 2 (1.3%) needed DJ stenting and 1 (0.6%) needed angioembolization. Intraoperative details indicated mean operative duration of  $81.2 \pm 9.4$  mins, while 07 patients required post-operative blood transfusion due to excessive blood loss. Total blood loss was estimated by calculating preoperative and post-operative hemoglobin difference, mean HB drop was reported as  $2.1 \pm 0.7$  mg/dL. Post-operative complications were documented and most commonly reported complication was hematuria in 141(92.7%) while 11(7.3%) uro-sepsis cases were reported as well (Table 1).

**Table 1.** Frequency of Reported Post-operative Complications in Study Participants.

Post-operative Complications	
Mucosal Tear	8 (5.2%)
Tight Ureter	11 (7.2%)
Transfusion required	7 (4.6%)
Hematuria	141 (92.7%)
Uro-sepsis	11 (7.3%)

Stone clearance was reported as 97% with 147(96.7%) complete stone free cases and 5(3.2%) cases with confirmed residual stones requiring METs to achieve complete clearance. The

assessment of CCI results were interpreted in odds ratio and results indicated that higher score of 3 and 4 has increased risk of severe complications including transfusion requirement (OR-1.21, CI95% 0.97-2.31) and Uro-sepsis (OR-2.19, CI95% 1.43-3.09) respectively.

Correlation of CCI and Clavien Dindo classification identified that there is a direct association with higher grading of both classification with post-operative complications. Patients from Grade III of Clavien Dindo classification had CCI grading of group 3 and 4 with frequency of 1(0.6%) and 2 (1.2%) in group 3 and 4 respectively. Assessment of odds of outcome were higher in Grade III Clavien Dindo with 1.48 (CI of 05% as 1.13 – 2.71) indicating positive odds of complications and CCI higher grading (Table 2 and 3).

**Table 2.** Correlation of CCI Divisions and Post-operative Complications within Study Participants.

Complications	CCI Grading				Odds Ratio	CI 95%
	Group 1* (n=52)	Group 2 (n=36)	Group 3 (n=36)	Group 4 (n=28)		
Mucosal Tear	1 (0.6%)	1 (0.6%)	4 (2.6%)	2 (1.3%)	0.71	0.14-1.31
Tight Ureter	5 (3.2%)	2 (1.3%)	3 (1.9%)	1 (0.6%)	0.46	0.09-0.92
Transfusion Required	0	1 (0.6%)	3 (1.9%)	3 (1.9%)	1.21	0.97-2.31
Hematuria	46 (30.2%)	31 (20.3%)	26 (17.1%)	21 (13.8%)	1.17	0.78-2.13
Uro-sepsis	0	1 (0.6%)	0	1 (0.6%)	2.19	1.43-3.09

\*(CCI Group 1 is reference category).

**Table 3.** Correlation of CCI Divisions and Clavien-Dindo Classification in Study Participants.

Clavien-Dindo Classification	CCI Grading				Odds Ratio	CI 95%
	Group 1** (n=52)	Group 2 (n=36)	Group 3 (n=36)	Group 4 (n=28)		
Grade I (n=119)	47 (30.9%)	31 (20.3%)	23 (15.1%)	18 (11.8%)	Ref	---
Grade II (n=30)	5 (3.2%)	5 (3.2%)	12 (7.8%)	9 (5.9%)	1.32	0.43-1.97
Grade III (n=3)	0	0	1 (0.6%)	2 (1.2%)	1.48	1.13-2.71

\*\* (CCI Group 1 is reference category). Ref: Reference category.

**DISCUSSION**

American urological association reported PCNL as procedure of choice for large renal stones of > 2.0 cms [11-13]. Our study reported overall stone free rates of 97%, which is similar to other studies reported from Pakistan and neighboring countries [1, 4]. We are currently living at a time of perpetual technical advancement, with our endoscopic devices constantly being updated. It includes downsizing, and Miniaturization of devices, believed to improve patient comfort (i.e., postoperative pain, complications rates, length of hospital stay, and blood loss) and support in the achievement of stone-free status in urolithiasis [6,11, 14].

The dynamics of percutaneous nephrolithotomy are altered by the miniaturization of its instruments, which affects a number of parameters such as the degree of parenchymal damage, intrapelvic pressures, and the necessity of a nephrostomy tube. These factors may also have an impact on other crucial variables like

bleeding, renal impairment, operating time, postoperative pain, length of hospital stay, etc. [15-18].

The association of gender and age categories with stone clearance was previously established in literature and results stated that elder aged patients had higher chances of post-operative complications, the reason was identified as associated comorbidities of elderly patients [19]. The Clavien classification used in this study is been evaluated and analyzed in several previous studies, which details the particular kinds of difficulties for each grade [20]. Charlson comorbidity Index is known to predict hospital stay, mortality and post-operative complication severity after surgical procedures [21]. Urological procedures were assessed by CCI in studies with results indicating positive association between greater risk of complications and higher CCI score [17, 19]. The results of our study showed higher incidence of complications in CCI score of more than >5, similar results were interpreted in another study with approximately 100% cor-

rect prediction of complications after surgery in > 5 CCI score patients. Some literature reviews defined CCI as multi-morbid ity scale, indicating multiple associated factors for mortality, however, our results showed that CCI and Clavien Dindo classification combined can predict overall hospital stay duration, post-operative complication rate and 30 days post discharge-mortality rates of patients. CCI can be used in all urological procedures to predict mortality and complications and might use used as helpful tool to counsel patients regarding morbidity and mortality [22-24].

One of the most important complication of PCNL is known to be bleeding and renal hemorrhage, not only because of blood loss but also because it can impair vision, which may cause premature termination of the procedure. The frequency reported in our study is 7(4.6%) within patients reported higher CCI score only, studies reported bleeding and renal hemorrhage incident from 1.3% to 9.5%. Higher chances of bleeding was reported in patients with DM, CKD stage III-IV and arteriosclerosis, with higher CCI scoring [25-28].

However, miniaturization of PCNL, usage of improved lithotripsy techniques are helpful in reducing complication rates, excessive operative duration and intra-operative and post-operative bleeding but the chances of severe complications are existing in elder patients with comorbidities, and CCI can be used as helpful tool for prediction and management of associated issues prior to surgery and choosing alternate management path as well [29-32].

## LIMITATION

The limitation of this study are cross-sectional study design, as the sampling is purposive, convenient but cross sectional identification of subjects raises biases chances. The study is prospective, however, longer follow up is required to assess 1-year mortality after PCNL. Another retrospective study with longer follow-up duration is recommended for further investigation and validation.

## CONCLUSION

Charlson Comorbidity Index is a swift, simple, and reproducible scoring system to properly calculate the morbidity and mortality after PCNL. Although, our results in the study seems to be comparable and PCNL is a very safe procedure in any age group, if surgeon is experienced well enough we can avoid complications in elderly people (even age > 90 years) and having high CCI score. However, in our setup, surgeon's experience is the main tool to avoid complications even those patients with higher CCI-score and age >90 years.

## AUTHORS' CONTRIBUTION

- **Anil Kumar Utraadi:** Objective, Write up.
- **Sharjeel Saulat:** Final approval, Surgery.

- **Jahanzeb Sheikh:** Final editing, Surgery.
- **Umer Rasheed:** Ethical consideration, Data collection.
- **Ashba Mushtaque:** Data collection, Data entry.
- **Muhammad Osama:** Data analysis, Results interpretation.

## CONFLICT OF INTEREST

Declared none.

## ACKNOWLEDGEMENTS

Declared none.

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