Can We Avoid Percutaneous Nephrolithotomy in High-risk Elderly Patients Using the Charlson Comorbidity Index?

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OBJECTIVE To determine whether Charlson comorbidity index (CCI) predicts the postoperative complications after percutaneous nephrolithotomy (PCNL) and could be a plausible option to avoid surgery and its potential risks in elderly patients with significant comorbidites.

METHODS The data from 283 elderly patients (age ≥60 years) who underwent PCNL in 4 large referral hospitals were reviewed in the present multicenter study. For each patient, we evaluated pre-existing comorbidities and calculated the CCI score. The patients were classified to 3 CCI score categories (0, 1, ≥2) and compared regarding the stone-free and complications rates.

RESULTS The mean patient age was 64.7, 65.6, and 67.7 years in the 3 groups. The stone-free rate after primary PCNL was 85.7% in group 1, 86.1% in group 2, and 75.0% in group 3. These rates increased to 90.8%, 95.4%, and 83.9% after a second intervention ($P = .049$). The overall postoperative complication rate was 38.8%. The most common complication was hemorrhage necessitating blood transfusion in 34 patients (12%), and we found an increased risk of hemorrhage associated with the CCI score ($P = .011$). Life-threatening medical complications developed in 7.6% of the patients in group 1, 12% of the patients in group 2, and 28.6% of the patients in group 3 ($P = .001$). A multivariate logistic regression analysis showed that a high CCI score, bleeding, and operative time had significant influence on the postoperative medical complication in this population.

CONCLUSION Conservative management of asymptomatic large kidney stones appears to be a safe alternative to PCNL in elderly patients with significant comorbidites. UROLOGY 79: 1042–1047, 2012. © 2012 Elsevier Inc.

Since the introduction of percutaneous nephrolithotomy (PCNL) in 1976, developing technology and techniques have made it possible to replace open surgery as the treatment of choice for renal calculi.[1] Despite its effectiveness, serious complications, such as blood loss, adjacent organ injuries, and life-threatening medical complications, have been identified because of PCNL and occur at reported rate of ≤83%.[2-4] Careful selection and preparation of the patients are very important for decreasing these complications. Therefore, it would be important to define which stones can be managed expectantly or should be surgically treated in high-risk patients.

The elderly population is the fastest growing segment in many parts of the world, and aging is 1 of the most important factors affecting the perioperative and postoperative morbidity.[5] Generally, older age is associated with a linear loss of function in all organ systems, and elderly patients might have a decreased physiologic reserve.[6] The presence of comorbid conditions is an important predictor of medical complications after surgery in the geriatric population. However, no currently available method has been accepted for predicting the complications after PCNL. The comorbidity index should be applied in daily clinical practice to assess the best therapeutic option in patients, including observation. The Charlson comorbidity index (CCI) is 1 of the most widely used comorbidity measures. Several studies have validated the ability of the CCI to predict mortality.[7] In the present multicenter study, we sought to determine whether

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CCI predicts the postoperative medical complications after PCNL, and this could be plausible option for avoiding surgery and its potential risks in the elderly patients with significant comorbidites.

MATERIAL AND METHODS

Patients

From September 2004 to March 2011, 1406 PCNL procedures were performed by 4 urology teams in 4 large referral hospitals in Ankara, Turkey. Of these, 283 PCNLs were performed on patients aged >60 years (mean 65.6). The patient assessment included medical history, physical examination, urinalysis, urine culture, complete blood count, serum biochemistry, coagulation tests, intravenous urography and/or computed tomography (CT). The stone size was determined by multiplying the stone length by the width in millimeters, as measured on preoperative excretory urography or CT in cases with radiolucent stones.

For each patient, we first evaluated the pre-existing comorbidities and calculated the CCI score.[7] The CCI features 19 conditions for which weighted scores of 1, 2, 3, or 6 are assigned according to the severity of the condition. The CCI score was derived by summing the weighted scores for all comorbidities. On the basis of the distribution of the CCI score in this cohort, the patients were classified into 3 CCI score categories (0, 1, ≥2).

Surgical Technique

At all centers, the procedure started with the patient in the lithotomy position, and rigid cystoscopy was performed to place a ureteral catheter. After ureteral catheter insertion, patients were placed in the prone or supine position, and percutaneous access was achieved under fluoroscopic guidance using an 18-gauge needle and guidewire. Tract dilation was accomplished using Amplatz, metal, or balloon dilators. Fragmentation and stone removal were accomplished in all patients using pneumatic or ultrasound energy and retrieval graspers through a rigid 11F, 15.9F, 22F, 24F, or 26F nephroscope. A total of 334 nephrostomy tracts were done in 283 patients. However, a low number of mini-PCNL procedures were performed in these elderly patients using 11F nephroscope (tract size, 12F; 2 patients) or 15.9F nephroscope (tract size 18F, 9 patients). In 99 patients, the nephrostomy tract was dilated ≤24F, and a 22F rigid nephroscope was used. In the remaining 224 patients, a 24F or 26F nephroscope was used, and the nephrostomy tract was dilated ≤26F or ≤28F. A holmium laser and nitinol basket catheter were used through flexible nephroscopes for locations unreachable using the rigid instruments. Stone clearance was determined by a combination of fluoroscopy and rigid or flexible nephroscopy at the end of the procedure and postoperatively by imaging with plain film and renal ultrasonogaphy. Intravenous urography and CT were not routinely used but were performed whenever needed. The patients with postoperative residual fragments of ≤3 mm were accepted to be stone free (clinically insignificant residual fragments). After completion of PCNL, a nephrostomy tube was placed and was routinely removed on postoperative days 1-3, and the patient was discharged home the next day. Although tubeless or totally tubeless PCNL was applied in selected patients at 2 centers, the other 2 centers opted for standard PCNL for all patients. The technique used for tubeless and totally tubeless PCNL has been previously described.[8,9] Blood loss was not considered significant, unless a transfusion was required. The patients with supracostal access underwent chest radiography to detect any chest complications.

Follow-Up

The first follow-up evaluation was performed 2-3 months after surgery, after which the patients were seen every 3-4 months during the first year and every 6 months thereafter. The follow-up period ranged from 1 to 40 months (median 12). At each visit, urinalysis, serum creatinine, plain film, and abdominal ultrasonography were performed.

Statistical Analysis

The patient demographics, stone characteristics, dilation technique, number and location of access points, blood loss, operation time, hospitalization time, stone clearance, postoperative medical and surgical complications, and auxiliary procedures were documented in detail and compared in each group.

All statistical analyses were performed using SPSS, version 15.0 (SPSS, Chicago, IL). Statistical significance was considered at $P < .05$. The chi-square test was used to evaluate the association between categorical variables. One-way analysis of variance and t test were used to compare the mean of the continuous variables. A logistic model was used to determine the odds ratios for statistically significant parameters affecting complications. The data are expressed as the mean ± standard deviation.

RESULTS

Patient and Stone Characteristics

The study group consisted of 146 women and 137 men 60-81 years old (mean 65.6). The CCI score was 0 for 119 patients (42.1%, group 1), 1 for 108 patients (38.1%, group 2), and ≥2 for 56 patients (19.8%, group 3). The mean patient age was 64.7 ± 4.18 years (range 60-81) in group 1, 65.6 ± 4.66 years (range 60-77) in group 2. and 67.7 ± 5.05 years (range 60-80) in group 3. The stone size was calculated by summing the length of the longest axis of each stone. The mean stone size was 31.3 ± 12.8 mm (range 12-80) in group 1, 32.8 ± 16.2 mm (range 11-80) in group 2, and 34 ± 15.6 mm (range 17-90) in group 3. No statistically significant difference was found in the stone size among the groups ($P = .679$). Stone analysis was available for 140 patients and revealed calcium oxalate/phosphate in 57 (40.7%), uric acid in 17 (12.1%), struvite in 10 (7.1%), cystine in 2 (1.4%), and a mixed composition in 54 patients (38.5%). The patient and stone characteristics are summarized in Table 1.

Operative Findings

The access to the kidneys was supracostal in 29 patients (10.2%). A single tract was used in 236 kidney (83.4%), 2 tracts in 43 (15.2%), and 3 tracts in 4 (1.4%). The operative time was calculated from the time of percutaneous needle access to completion of nephrostomy tube placement. The mean operative time was 62.3 ± 21.4, 63.4 ± 20.8, and 70 ± 24.6 minutes in groups 1, 2, and

Table 1. Demographic and surgical data

Variable	Total	Group 1	Group 2	Group 3	*P* Value
Patients (n)	283	119 (42.1)	108 (38.1)	56 (19.8)	
Age (y)	65.69 ± 4.66	64.7 ± 4.18	65.6 ± 4.66	67.7 ± 5.05	.001*
Sex					
Male	137 (48.4)	54 (45.4)	53 (49.1)	30 (53.6)	.59
Female	146 (51.6)	65 (54.6)	55 (50.9)	26 (46.4)	
Stone size (mm)	32.4 ± 14.7	31.3 ± 12.8	32.8 ± 16.2	34 ± 14.7	.679
Access location					
Subcostal	254 (89.8)	108 (90.7)	95 (87.9)	51 (91)	
Supracostal	29 (10.2)	11 (9.3)	13 (12.1)	5 (9)	
Dilation technique					
Amplatz	250 (88.3)	100 (84)	98 (90.7)	52 (92.9)	
Metal	9 (3.2)	6 (5)	2 (1.9)	1 (1.8)	
Balloon	24 (8.5)	13 (10.9)	8 (7.4)	3 (5.4)	
Operative time (min)	64.3 ± 22	62.3 ± 21.4	63.4 ± 20.8	70.4 ± 24.6	.179
Initial stone-free rate (%)	83.7	85.7	86.1	75	.14
Final stone-free rate (%)	91.2	90.8	95.4	83.9	.049*
Hospitalization time (d)	3.06 ± 1.2	2.9 ± 1.02	3.09 ± 1.24	3.34 ± 1.41	.246

Data presented as mean ± SD or numbers, with percentages in parentheses.
* Statistically significant at $P < .05$.

3, respectively. This difference was not statistically significant ($P = .179$). Tract dilation was performed using a balloon dilator in 8.5%, metallic telescopic dilator in 3.2%, and Amplatz serial dilator in 88.3% of the procedures. No statistically significant differences were found between the patients using Amplatz and balloon dilation techniques for stone-free rates ($P = .142$), hemorrhage ($P = .089$), and medical complications ($P = .753$). The stone-free rate after primary PCNL was 85.7% in group 1, 86.1% in group 2, and 75.0% in group 3 ($P = .140$). A second intervention was used in 41.1% of group 1, 73.3% of group 2, and 50% of group 3 patients, and the stone-free rate increased to 90.8%, 95.4%, and 83.9% in groups 1, 2, and 3, respectively ($P = .049$). In group 1, most of the patients with residual stones had asymptomatic residual fragments <7 mm in the lower pole of the kidney after the primary procedure. These patients did not want an additional procedure and were followed up with ultrasonography. The mean hospital stay was 3.06 ± 1.2 days (range 1-9), and no significant difference was found among the groups for the mean hospital stay ($P = .246$). The operative, postoperative, and stone clearance data are detailed in Table 1.

Postoperative Surgical Complications

A total of 110 complications (38.8%) were encountered in 77 patients (27.2%). Of the complications, 72 (25.4%) were directly related to surgery and 38 (13.4%) were medical complications. The most common complication was hemorrhage necessitating blood transfusion in 34 cases (12%), but it was mostly clinically insignificant. Of the 34 patients requiring a blood transfusion, 9 (7.6%) were in group 1, 12 (11.1%) were in group 2, and 13 (23.2%) were in group 3, with most patients receiving 1 U of blood ($P = .011$). Also, CCI score was analyzed as a continuous variable, and we found an a significant association between high CCI score and hemorrhage necessitating blood transfusion ($P = .004$). The hemoglobin decrease ranged from 0.1 to 6.5 g/dL; however, in most patients, it was <2 g/dL. A total of 22 patients (7.8%) had fever requiring antipyretics, and 9 (3.1%) had urine leakage from the nephrostomy tract after removal of the tube. Major complications included urosepsis in 0.7%, pneumothorax/hydrothorax in 1.4%, and colon injury in 0.3%.

Postoperative Medical Complications

Postoperative medical complications, such as pulmonary embolism, ischemic stroke, acute coronary syndrome, hypertensive crisis, arrhythmia, organ dysfunction, or gastrointestinal bleeding developed in 9 patients (7.6%) in group 1, 13 (12%) in group 2, and 16 (28.6%) in group 3 ($P = .001$). When the CCI score was used as a continuous variable, a significant association was found between the CCI score and the incidence of medical complications ($P < .001$). One patient (0.3%) with preoperative cardiovascular system problems died 4 hours after surgery of myocardial infarction. The postoperative complication rates, stratified by CCI score group, are listed Table 2.

Univariate analysis showed that a higher CCI score (as both a continuous and a categorical variable, $P = .001$), stone size ($P = .027$), bleeding ($P < .001$), and operative time ($P = .07$) were significantly related to greater medical complication rates (Table 3). A multivariate logistic regression analysis, including all variables, also revealed that a high CCI score (as a continuous and categorical variable, $P = .001$), incidence of bleeding, and operative time had significant influence on the incidence of medical complication after PCNL.

COMMENT

PCNL is an established procedure for large and complex renal calculi.[10] It has the advantages of greater

Table 2. Effect of CCI score on PCNL complications

Variable	Total	Group 1	Group 2	Group 3	*P* Value
Patients (n)	283	119 (42.1)	108 (38.1)	56 (19.8)	
Bleeding requiring transfusion	34 (12)	9 (7.6)	12 (11.1)	13 (23.2)	.011*
Postoperative fever	22 (7.8)	14 (11.8)	5 (4.6)	3 (5.4)	.101
Urosepsis	2 (0.7)	1 (0.8)	1 (0.9)	—	
Injury to adjacent organs					
Lung or pleural	4 (1.4)	3 (2.5)	1 (0.9)	—	
Colon injury	1 (0.3)	—	—	1 (1.7)	
Medical complications	38 (13.4)	9 (7.6)	13 (12)	16 (28.6)	.001*
Pulmonary embolism	4 (1.4)	1 (0.8)	2 (1.8)	1 (1.7)	
Ischemic stroke	2 (0.7)	1 (0.8)	1 (0.9)	—	
Acute coronary syndrome	7 (2.4)	2 (1.6)	2 (1.8)	3 (5.3)	
Arrhythmia	11 (3.8)	2 (1.6)	4 (3.6)	5 (8.9)	
Hypertensive crisis	10 (3.5)	2 (1.6)	3 (2.7)	5 (8.9)	
Gastrointestinal bleeding	2 (0.7)	1 (0.8)	—	1 (1.7)	
Organ dysfunction	2 (0.7)	—	1 (0.9)	1 (1.7)	
Perioperative mortality	1 (0.3)	—	—	1 (1.7)	

Data presented as mean ± SD or numbers, with percentages in parentheses.
* Statistically significant at $P < .05$.

Table 3. Effect of some variables on medical complications

Variable	Patients (n)	Medical Complications		*P* Value
		Yes	No	
Age (y)		66.8 ± 4.94	65.5 ± 4.59	.097
Sex				.108
Male	137 (48.4)	23 (16.8)	114 (83.2)	
Female	146 (51.6)	15 (10.2)	131 (89.8)	
Stone size (mm)		36.4 ± 15.9	31.8 ± 14.5	.027*
Operation time (min)		73.8 ± 23.2	62.8 ± 21.4	.007*
Hemorrhage (n)	38 (13.4)	11 (28.9)	23 (9.3)	< .001*
Dilation technique				.723
Amplatz	250 (88.3)	35 (92.1)	215 (87.8)	
Metal	9 (3.2)	1 (2.6)	8 (3.2)	
Balloon	24 (8.5)	2 (5.3)	22 (9)	
CCI score				.001*
0	119 (42.1)	9 (7.6)	110 (92.4)	
1	108 (38.1)	13 (12)	95 (88)	
≥2	56 (19.8)	16 (28.6)	40 (71.4)	

Data presented as mean ± SD or numbers, with percentages in parentheses.
* Statistically significant at $P < .05$.

rates of stone clearance, cost-effectiveness, and early convalescence compared with other modalities, such as shock wave lithotripsy and open surgery. Although studies have reported excellent outcomes and relatively low morbidity in healthy adult patients, few have analyzed the safety and efficacy of PCNL in elderly patients.[11-14]

The geriatric population is the fastest growing segment in many parts of the world. Most developed countries have accepted the chronologic age of 65 years as a definition of "elderly" or older person; however, the United Nations-agreed cutoff is 60 years to refer to the older population. Age itself is not an illness; however, the changes in cardiopulmonary reserve of the elderly patients make them less tolerant to certain stressors, such as an increase in demand during the perioperative period, bleeding, or medical complications.[5,15] Therefore, careful selection and preparation of the patients are very important in the geriatric population for decreasing life-threatening complications.

Some studies have assessed the efficacy of PCNL for renal stones in the geriatric population. In 1994, Stoller et al[11] retrospectively reviewed 42 PCNL operations on 33 patients aged ≥65 years and compared them with younger patients. They demonstrated that PCNL is a safe and effective therapy for elderly patients, even with complex stone disease; however, they found a greater transfusion rate in this group. In 2001, Sahin et al[13] reported the results of PCNL for 27 patients >60 years, and they found that the PCNL procedure was equally feasible and safe in the elderly as in a younger patient population. In a recent study, Anagnostou et al[12] reported no statistically significant differences between the elderly (≥70 years) and younger control (<69 years) groups for the stone-free and complication rates of PCNL. However, many of these studies, which reported comparable complications in geriatric patients compared with their younger counterparts, included small-size elderly patients.

Our results highlight that elderly patients who undergo PCNL for kidney stones have various preoperative comorbidities. Almost 3-5 of the patients in this series had preoperatively identified comorbidities. Also, these patients had significantly greater rates of complications than those with no comorbidities. Diabetes mellitus was shown to be associated with a significantly increased incidence of complications, including bleeding requiring blood transfusion.[16] Some studies have suggested an increased postoperative morbidity in the morbidly obese patient because of a greater incidence of wound infection and thromboembolic events. Pearle et al[17] found that PCNL in the morbidly obese patient yielded success and complication rates and hospital stay lengths comparable to those of an unselected patient population. Symons et al[18] studied 29 patients with spinal neuropathy who underwent 39 PCNL procedures. The stone-free rate was only 62% from the initial procedure, and the morbidity of the procedure was significantly high, with 2 postoperative deaths.

According to our univariate analysis, the preoperative comorbidities, stone size, bleeding incidence, and operative time were found to be factors affecting the incidence of complications after PCNL. However, in the multivariate analysis, including all variables, only preoperative comorbidities, bleeding, and operative time had significant influence on the postoperative complication rates. Therefore, it would be important to define which stones could be managed expectantly or should be surgically treated in this population. The observation strategy can be affected by the stone composition; for example, an untreated struvite calculi is likely to destroy the kidney and cause life-threatening sepsis.[19] Various rating scales have been validated for assessing comorbidity in elderly patients; however, the CCI is the most widely used comorbidity index. The CCI encompasses 19 medical conditions weighted 1-6, with total scores of 0-37 In our study, we evaluated this index to determine whether it predicts postoperative complications after PCNL in elderly patients, and we found it to be a significant predictor of morbidity.

Also, in this context, higher CCI score was significantly associated with the lower stone-free rates after PCNL ($P = .049$), despite the groups having a comparable stone burden ($P = .679$) and mean operative times ($P = .179$). Patients with high CCI score had a significantly greater rate of renal hemorrhage during surgery, which might contribute to some of the disparity in the stone-free rates. Some studies have suggested increased postoperative bleeding in patients with diabetes mellitus, atherosclerosis, obesity, and hypertension.[16-21] In the present study, perioperative bleeding requiring a blood transfusion was observed in 34 patients (12%); however, the operation had to be terminated because of severe bleeding in only 3 patients (1.1%). In the published data, blood loss requiring transfusion has been reported in 0.4%-23% of cases and was associated with the stone burden, sheath size, number of tracts, and operative time.[2,20,22] Tefekli et al[16] reported that the risk of major complications, especially hemorrhage, is significantly elevated during PCNL in patients with diabetes mellitus, hypertension, and the metabolic syndrome. Associated arteriosclerosis with thickened basement membranes might make these patients more prone to bleeding after the initial trauma of tract formation. Kukreja et al[20] showed that the method of tract dilation, multiple (>2) tracts, tract size, renal parenchymal thickness, and diabetes mellitus were significant predictors of blood loss and the need for transfusion.

Despite PCNL's effectiveness, serious complications, such as blood loss, adjacent organ injuries, and life-threatening medical complications, have been identified because of PCNL and occur at reported rate of ≤83%.[2-4] The Clavien system has been modified to grade the complications of PCNL. Today, ureteroscopic treatment of renal calculi provides an alternative to PCNL, potentially achieving greater stone-free rates than shock wave lithotripsy, with lower morbidity than PCNL.[23] Recent studies have reported stone-free rates >90% for retrograde ureteroscopic management of renal stones and as great as 85% for the management of lower pole stones.[23,24] Furthermore, retrograde intrarenal surgery (RIRS) can minimize the risks associated with percutaneous renal surgery, such as bleeding, pleural or visceral injury, and urine leak. In our another study, we compared the safety and efficacy of PCNL and RIRS for lower pole renal stones in adult patients. In the RIRS group, no medical complication or major surgical complications occurred. We found that the stone-free rate and complication rate were greater with the percutaneous approach, although the difference was not statistically significant.[25] Therefore, RIRS is a safe procedure in high-risk patients, such as obese patients, elderly patients, pregnant women, and those with coagulopathy, in whom PCNL might be contraindicated.

The present study had some limitations owing to its retrospective nature. Not all patients were postoperatively evaluated using CT, and some differences were present in the postoperative imaging procedures of the 4 centers. Although this is 1 of the largest series of the association of comorbidity status and postoperative outcomes in elderly patients, larger patient numbers are required to more clearly analyze the described associations.

CONCLUSIONS

We identified patient comorbidity status, prolonged operative time, and perioperative bleeding as risk factors for postoperative complications after PCNL. Therefore, RIRS or conservative management of kidney stones might be a safe alternative to PCNL in elderly patients with a high CCI score.

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Appendix 1. Charlson comorbidity index

Weight	Clinical Condition
1	Myocardial infarction
1	Congestive heart failure
1	Peripheral vascular disease
1	Dementia
1	Cerebrovascular disease
1	Chronic pulmonary disease
1	Connective tissue disease
1	Ulcer disease
1	Mild liver disease
1	Slight diabetes without complications
2	Hemiplegia
2	Moderate to severe renal disease
2	Diabetes with end organ damage
2	Tumors
2	Leukemia
2	Lymphoma
3	Moderate or severe liver disease
6	Metastatic solid tumor
6	Acquired immunodeficiency virus