Percutaneous Nephrolithotomy in the 80 Years of Age and Older Population

Zain A Abedali[1], Tim Large[1], Joshua M Heiman [1], Elhaam Bandali [1], Blake B Anderson [1], James E Lingeman [1], Amy E Krambeck [2]

1. Department of Urology, Indiana University/IU Health Physicians, Indianapolis, IN.
2. Department of Urology, Indiana University/IU Health Physicians, Indianapolis, IN. Electronic address: akrambeck@iuhealth.org.

ABSTRACT

OBJECTIVE

To evaluate feasibility of percutaneous nephrolithotomy (PCNL) for complex nephrolithiasis in patients 80 years of age and older compared to younger individuals.

METHODS

From an institutional IRB-approved database, 1,647 patients were identified who underwent PCNL from 1999 to 2019. Patients were stratified by age: group 1 (20-59), group 2 (60-79), and group 3 (>80). Statistics were performed using chi-square and ANOVA to compare outcomes.

RESULTS

Of the 1,647 patients, median age was 46, 66, and 83, respectively (P <0.0001). Three patients within group 3 were 90 or older. Females made up 54%, 46%, 56% of patients (P = 0.02). Average stone size with SD was 2.6 ± 2.2, 2.5 ± 2.3, 2.2± 1.9 cm for each group (P = 0.06). Mean preoperative hemoglobin (Hgb) was significantly lower in the 80+ group (13.8, 13.4, 13.1 g/dL, P <.0001). Change in Hgb was not significantly different. There were more Clavien II-IV complications (10.4, 14.4, 28.8%; P = 0.02) and transfusions (2.3, 4.7, 10.2%; P <0.001) in the elderly. The most common complications in the 80+ group were bleeding related (10.1%). No difference in readmission rates or ICU admissions was noted.

CONCLUSION

PCNL is feasible in the extremely elderly; however with a higher rate of complications and longer hospitalizations. No long-term sequelae or deaths in the 80 and older cohort were seen. This study allows us to appropriately counsel older patients on a realistic postoperative course and supports use of PCNL as the best means of long-term survival.

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Since the introduction of percutaneous nephrolithotomy (PCNL) as a method of treating complex renal stones, open surgery to treat nephrolithiasis has essentially been replaced.[1], [2] In the setting of large stone disease, atypical genitourinary anatomy, and infectious stones, PCNL is considered the standard of care.[3], [4], [5] With both an increase in life expectancy and in surgical procedures performed in the elderly, the need for understanding operative risk of PCNL in older patients is understood.[9], [10] Standard risks of PCNL include infection, hemorrhage requiring transfusion, intrarenal or retroperitoneal hematoma or urinoma, prolonged nephrostomy tube or ureteral stenting, and injury to surrounding organs and additional anesthetics for secondary procedures.[6], [7], [8] Increasing age has even been associated with an increase in blood transfusion risk.[11] Multivariate analysis has suggested that increased age is both an independent predictor of postoperative complications and associated with increased mortality during hospitalization.[4] Literature has nonetheless demonstrated that with the expertise of an experienced surgeon, PCNL can be safely performed as patient age exceeds 60, 65, and even 70 years old.[12], [13], [14]

It is well accepted that advances in age are associated with increases in comorbidities. Despite only 2% of the US population being 80 or older, there are multiple occurrences of complex stone disease in octogenarians. Therefore, as our urologic advancements continue to minimize the operative trauma associate with percutaneous stone surgery, we remain compelled to evaluate the safety of PCNL and its efficacy in very elderly patients. The purpose of this study is to evaluate our institutional experience and compare outcomes and complications of PCNL in patients 80 years and older compared to their younger cohorts.

METHODS

This is a retrospective study of patient records from our IRB-approved collected PCNL database for patients in the Department of Urology at Methodist Hospital which is part of Indiana University/IU Health. The eligibility criteria included patients who underwent PCNL for upper urinary tract stone disease between 1999 and 2019 and who gave consent for their medical records to be utilized for research purposes. Exclusion criteria

included patients with active bleeding diatheses, patients under 18 years of age, and those who were pregnant.

All patients (n = 1647) in the PCNL database were examined preoperatively including medical histories for comorbidities, physical examination to assess body habitus, standard imaging (CT scan), and urine culture. Patients underwent prone PCNL using fluoroscopic guidance; access was obtained by the urologist in the operating room using triangulation technique. Percutaneous access tracts were balloon dilated to accommodate a 30 French sheath. Rigid and flexible nephroscopy were performed as needed. Ultrasonic and pneumatic lithotripsy were employed for most cases. Flexible nephroscopy was performed in all cases to assess the entire collecting system. For isolated calculi, holmium laser lithotripsy with basket extraction was utilized. All patients had a nephrostomy tube placed at the conclusion of the procedure, with or without an additional reentry catheter, overnight. Noncontrast CT scans were obtained on postoperative day one, with secondary procedures (repeat PCNL or ureteroscopy) following for patients with residual stone burden. Those without residual stones underwent a formal nephrostogram or methylene blue testing which was surgeon specific. Methylene blue testing involves injection of the dye into the nephrostomy tube. Blue, green discoloration of the patients urine within the urinary catheter tubing within 15 minutes of methylene blue administration signaled a successful demonstration of antegrade ureteral flow. In the setting of a normal nephrostogram or successful methylene blue test, the nephrostomy tube was removed along with the transurethral urinary catheter. Patients were discharged on postoperative day one, unless they underwent a secondary procedure. Follow-up clinic visits were scheduled between 6 and 12 weeks, with an US and KUB at 6 weeks postprocedure.

Pertinent baseline and preoperative data and perioperative outcomes were collected. Baseline variables included patient demographics and comorbidities as well as details about the stone size and location. Perioperative outcome variables included laboratory values, complications using the Clavien classification system within 30 days of the surgical procedure, transfusion rates, length of stay, and presence of a drainage tube at time of discharge.

Data were statistically analyzed using the SPSS statistical software package. Patients were stratified into 3 groups based on age: 20-59, 60-79, and 80+ years old. The decision to stratify into 3 groups was based on established increased risk of complications and hospitalization lengths with age.[4] Frequencies and descriptive statistics including the mean and standard deviations were reported. The Pearson chi-square test and ANOVA statistical tests were used to compare outcomes between the 80+ and younger cohort groups.

RESULTS

In Table 1**,** the baseline characteristics of the 1,647 patients are shown. Preoperatively, there were significantly higher number of patients with diabetes (17% for 20-59, 28% for 60-79, and 22% for 80+, *P* <.001) and hypertension (35% for 20-59, 54% for 60-79, and 51% for 80+, *P* <0.001) in the 65 to 79-year-old group as compared to the other groups (Table 1). Mean preoperative hemoglobin (Hgb) was significantly lower in the 80 and over group when compared to the other 2 groups (13.8 for 20-59, 13.4 for 60-79, and 13.1 g/dL for 80+, *P* <.0001). Mean serum creatinine was highest in the 65 to 79-year-old and 80+ years old group (1.1 for 20-59, 1.2 for 65-79, 1.2 for 80+, *P* <.001). Intraoperative characteristics including access details, stone composition, and positive culture rates are reported in Table 2. The octogenarian population had greater rates of calcium oxalate, hydroxyapatite, and brushite stones as well as lower rates of uric acid, cystine, struvite, and “other” stone compositions with an overall statistically significant difference in stone analysis (*P* = .003).

Table 1. Baseline and preoperative characteristics

Group	20-59 (N = 1022)	60-79 (N = 566)	80+ (N = 59)	*P*
Age (Med + IQR)	46 ± 18	66 ± 9	83 ± 4*	
Female %	550 (54%)	263 (46%)	33 (56%)	.02
Diabetes (%)	169 (17%)	157 (28%)	13 (22%)	<.001
Hypertension (%)	353 (35%)	308 (54%)	30 (51%)	<.001
Renal failure (%)	21 (2%)	10 (2%)	4 (7%)	.04
BMI ± SD	32.1 ± 9.9	32.4 ± 8.6	26.1 ± 4.6	<.001
SCr (mg/dL) ± SD	1.1 ± 0.6	1.2 ± 0.6	1.2 ± 0.5	<.001
S Hgb (g/dL) ± SD	13.8 ± 1.8	13.4 ± 1.8	13.1 ± 1.4	<.001
Ave stone size + SD (cm)	2.6 ± 2.2	2.5 ± 2.3	2.2 ± 1.9	.06
Laterality (%)				
Left	442 (43%)	223 (390%)	23 (39%)	.4
Right	338 (33%)	196 (35%)	24 (41%)	
Bilateral	232 (24%)	147 (26%)	12 (20%)	

BMI, body mass index; IQR, interquartile range; SD, standard deviation.
* Three patients were over the age of 90 years.

Table 2. Intraoperative characteristics

Group	20-59 (N = 1022)	60-79 (N = 566)	80+ (N = 59)	*P* Value
Puncture location				
Lower	762 (74.5%)	374 (66.1%)	40 (67.7)	<.001
Mid	5 (4.9%)	23 (4.1%)	4 (6.8%)	
Upper	128 (12.5%)	108 (19.1%)	10 (16.9%)	
Multiple	127 (12.4%)	61 (10.7%)	5 (8.6%)	
Number Access	1.4 (1-5)	1.2 (1-3)	1.2 (1-3)	<.001
Stone analysis				
Calcium oxalate	386 (37.8%)	274 (48.4%)	25 (42.4%)	.003
Hydroxyapatite	304 (29.8%)	126 (22.3%)	21 (35.6%)	
CAP/Brushite	73 (7.2%)	38 (6.7%)	6 (10.2%)	
Uric acid	79 (7.7%)	66 (11.6%)	4 (6.7%)	
Cystine	38 (3.7%)	3 (0.5%)	0 (0%)	
Struvite	43 (4.2%)	24 (4.3%)	2 (3.4%)	
Other	99 (9.6%)	35 (6.2%)	1 (1.7%)	
(+) Stone culture	240/676 (36%)	128/385 (33%)	22/48 (46%)	.14

The percent of patients with postoperative complications was highest in the 80+ group (28.8% vs 14.4%—group 2 and 10.4%—group 1). Table 3 reports full details on complication rates; there were more Clavien II-IV complications in the 80+ cohort compared to other age groups. The most common Clavien II complication in the 80+ group was acute blood loss requiring transfusion. The Clavien III complication seen most often was respiratory distress. Sepsis was the most severe Clavien IV complication suffered by a single 80+ patient. The transfusion rate was also highest in the 80+ age

group (2.3% for 20-69, 4.8% for 60-79, 10.2% for 80+, *P* <.001). The most common overall complication in the 80+ group was bleeding complications (11%) requiring clot evacuation (1.7%), pseudoaneursym embolization (1.7%), and double J-stent placement for clot-related colic (1.7%). There was no statistically significant difference in change from pre- to postoperative hemoglobin among the groups. The length of stay was longer in the 80+ group (2.3 days for 20-59, 2.7 days for 60-79, 3.0 days for 80+, *P* <.01). However, no difference in readmission rates or ICU admissions was noted between groups. There was one death noted in the 65-79 years of age cohort, which occurred in a 71-year-old man with bilateral staghorn calculi in a shoehorn kidney who was found unresponsive on postoperative day 1 presumed to be from a cardiac event based on autopsy.

Table 3. Perioperative outcomes

Group	20-59 (N = 1022)	60-79 (N = 566)	80+ (N = 59)	*P* Value
Retroperitoneal hematoma rate (%)	31 (3.0%)	14 (2.4%)	5 (8.4%)	.02
Postop S Cr (mg/dL) ± SD	1.2 ± 0.6	1.4 ± 0.7	1.4 ± 0.5	<.001
Postop S Hgb (g/dL) ± SD	11.7 ± 1.7	11.5 ± 1.7	11.2 ± 1.5	.003
Change in Hgb (g/dL) ± SD	2.0 ± 1.4	1.9 ± 1.5	1.7 ± 1.3	.02
Transfusion rate (%)	23 (2.3%)	27 (4.8%)	6 (10.2%)	<.001
Complication rate (%)	107 (10.4%)	82 (14.4%)	17 (28.8%)	<.001
Complication grade N (%)				
Clavien I	81 (7.9%)	41 (7.2%)	4 (6.8%)	<.001
Clavien II	13 (1.3%)	20 (3.5%)	6 (10.2%)	
Clavien III	4 (0.4%)	10 (1.8%)	5 (8.5%)	
Clavien IV	9 (0.9%)	10 (1.8%)	2 (3.4%)	
Clavien V	0	1 (0.2%)	0	
Need for secondary stone PCNL/URS	450 (44%)	254 (45%)	19 (32%)	.18
Length of stay (days) ± SD	2.3 ± 1.9	2.5 ± 2.0	3.0 ± 2.5	.008
ICU admission (%)	12 (1.2%)	14 (2.5%)	2 (3.4%)	.08
Readmission (%)	10 (1.0%)	9 (1.6%)	1 (1.7%)	.5
DC with Neph Tube (%)	29 (2.8%)	13 (2.3%)	2 (3.4%)	.7
IR embolization rate (%)	6 (3.2%)	2 (3.5%)	1 (1.7%)	.4
Stone free**	537 (81.9%)	327 (82.9%)	32 (72.7%)	.02

DC, discharge; PCNL, percutaneous nephrolithotomy; URS, ureteroscopy.
** Stone free based on post operative CT abdomen and pelvis.

DISCUSSION

This study demonstrates that PCNL in the aging population, specifically 80 years of age and older, is a safe and effective surgical treatment for complex nephrolithiasis. Patients over the age of 80 years are likely to present with anemia or renal insufficiency compared to their younger counterparts. Postoperatively, the 80+ group of patients demonstrated 2-

3 times and 2-4 times greater risk of having a complication or needing a blood transfusion. However, no difference was seen in ICU admission or readmission rates between age groups.

As our population ages a number of groups have sought to explore the outcomes of PCNL in older populations. Both Sahin and Buldu et al looked at patients 60 and older and how their patients fared compared to younger patients. They found that 66% and 88% of their older cohort had a comorbidity such as hypertension, diabetes mellitus, or chronic obstructive pulmonary disorder[9] which is similar to our experience where 65% of patients 80 years of age and older had hypertension, diabetes, and/or renal insufficiency. Metabolic syndrome is also an increasing issue and is associated with renal stone development. Even in our 80+ patients BMIs ranged up to 35 with an average of 26.2 making the cohort overweight.[15] Despite high rates of patient comorbidities, 55% of the patients 80 years and older had a postoperative CT without stones, no complications, and were discharged with an average stay of 2 days.

When looking at overall stone free rates after secondary procedures for residual stones, we found that 72.7% of our octogenerians were stone-free which was lower than our younger 2 cohorts (81.9% in 20-59, 82.9% in 60-79, $P = .02$), a comparable finding to previous publications. Morganstern et al showed similarly that in older patients SFRs were lesser than their younger counter parts (82% in <65, 78% in >80, $P = .23$). Compared to our younger cohort, the frequency of stone compositions did differ amongst the groups. This is especially interesting that despite more comorbidities, there were not higher rates of infectious stones. The importance of this study highlights a similar conclusion of the 1973 sentinal paper by Singh et al (Singh M, Chapman R, Tresidder GC, Blandy J. The fate of the unoperated staghorn calculus. BJU Int. 1973) in suggesting that age alone should not deter us from percutaneous stone surgery and that when safe the best option for long-term survival is to surgically remove large kidney stones.

In Nakamon et al's study they assessed the safety and efficacy of PCNL in patients older than 65 and reported a complication rate of 13.1% in their elderly population with a significantly higher rate of sepsis.[13] Anagnostu's et al observed a complication rate of 14.1% in their elderly group, defined as 70 and older, with one patient dying in the

postoperative period due to a PCNL-related complication.[14] One study showed PCNL in octogenarians was feasible with a 36% complication which is similar to our finding 25.9% complication rate; however, they did not find this to be significantly different than their younger control group.[16] The results herein demonstrate that with increasing age past 80, the risk of complications of with PCNL also increase. However, no patients 80 years of age or older in our current study suffered long-term sequalae and no deaths were observed.

The results of our current study must be viewed in the context of certain limitations. This retrospective review here does not have the benefit of being a randomized control trial. Nonetheless, this is, to our knowledge, the largest report on patients over the age of 80 years undergoing PCNL and their relative risks of surgery. Furthermore, the increased risk of bleeding seen in our elderly population of interest may be due to a higher incidence of anticoagulation and baseline anemia within the cohort. Future work will address whether there is an association between those factors. Finally, there is likely variance due to the wide range of years that our patients underwent surgery. However, some of the variation is mitigated by the study being high volume, over 1500 patients, at a single institution.

These limitations notwithstanding, the current study provides support to the use of PCNL in the extreme aging patient population. It can be a safe and effective treatment method for renal stones when understood that there may be an increased risk of complications, namely blood loss requiring transfusion. Previous literature has detailed the efficacy of PCNL for elderly patients, but as life expectancy continues to increase there is a need to explore the question for patients over the age of 80 years.

CONCLUSION

Percutaneous nephrolithotomy is feasible in patients 80 years of age and older. Our results demonstrate the procedure to be relatively safe and effective in this extreme aging population, while acknowledging that these patients have higher rates of complications, particularly bleeding requiring transfusion. We reported no deaths or long-term sequelae in our 80+ PCNL cohort. After hematologic risks are considered, PCNL offers the best option for long-term survival in appropriately selected patients over the age of 80 years.

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