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The effects of percutaneous nephrolithotomy on renal function in geriatric patients in the early postoperative period

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Abstract Since percutaneous nephrolithotomy (PNL) is a surgical intervention, it may show deteriorative effects on renal function in the early postoperative period. In this study, the deteriorative effects of PNL on renal function were investigated in the geriatric population, and it was compared to the non-geriatric population.

A total of 711 patients [64 in the geriatric group (female/male ratio: 33/31, mean age: 70.4 ± 4.2 years), 647 in the non-geriatric group (female/male ratio: 267/380, mean age: 40.9 ± 12.7 years)] were included in the study. Demographic data, biochemical parameters, stone diameters, duration of the operation and estimated glomerular filtration rates (eGFR) were recorded both preoperatively and postoperatively.

The eGFR ratio (post-/preoperative) was 1.13 ± 1.00 in the geriatric group, 0.98 ± 0.20 in the non-geriatric group ($P < 0.001$). Although the mean stone diameter was larger in the geriatric group than the non-geriatric group (10.08 ± 6.5 mm, 8.28 ± 5.54 mm, $P = 0.037$), the mean duration of the operation was shorter in the geriatric group than in the non-geriatric group (55.7 ± 13.6 min, 61.3 ± 20.9 min, $P = 0.036$). Hematocrit, hemoglobin, urea levels, and grade of hydronephrosis were not different between the groups.

Renal function impairment is expected to be common in the geriatric patient population since they already have lower basal renal function. In the present study, the ratio of postoperative to preoperative eGFR was higher in the geriatric group. Hematocrit, hemoglobin, and urea levels and degree of hydronephrosis of these two groups did not show a great difference. The relatively short duration of the operation in the geriatric group and the diversity of perioperative and postoperative care of these two groups may explain the difference.

Keywords Early postoperative period · Geriatric patients · Glomerular filtration rate · Percutaneous nephrolithotomy · Renal function · Renal stone

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Introduction

Renal stone (RS) is sometimes a challenging problem in routine urology practice. The spontaneous stone passage rate dramatically decreases if the diameter is greater than 7 mm [1]. Although till now open surgery has been the main treatment option, percutaneous nephrolithotomy (PNL) appears to have a comparable success rate to open renal and ureteral surgery in the management of nephrolithiasis with lower postoperative morbidity, more rapid convalescence, less hospital cost, and greater patient satisfaction [2].

As the mean age of the population steadily increases, the number of elderly patients with renal stones also increases. The geriatric population may be more prone to perioperative and early postoperative complications of surgical interventions, since they have lower basal cardiac and renal functions [3]. In this study, we aimed to compare the renal functional effects of PNL at the early postoperative period in the geriatric and non-geriatric population.

Materials and methods

The patients who had undergone successful PNL in Haseki Training and Research Hospital between 2002 and 2007 were included in this retrospective study. The patients who were 65 years old or older were defined as the geriatric group (GG) and the others as the non-geriatric group (NGG), and their demographic data were collected from their charts.

The diagnosis of the RS was confirmed by direct urinary roentgenogram, intravenous pyelography, ultrasonography and/or computerized tomography. The stone diameter and the grade of hydronephrosis were recorded.

Biochemical analyses (urea, creatinine, hemoglobin, and hematocrit) were also performed preoperatively and early postoperatively (12–24 h after the operation). Estimated glomerular filtration rate (eGFR) was calculated by the original Cockcroft–Gault formula; eGFR (ml/min) = [140-age (years)] $\times$ weight (kg) $\times$ (0.85 for women)/[72 $\times$ serum creatinine (mg/dl)] [4].

A 5-F ureteral catheter was placed in all patients, except those with a preexisting double-j stent before PNL, and this external ureteral stent was left secured to the Foley catheter. Percutaneous access was performed on patients in prone position on the urological table (ModularisUro, Siemens) with all pressure points padded. Percutaneous access was obtained at a single setting in the operating room with C-armed fluoroscopy, and the tract was dilated with a high-pressure balloon dilator (Nephromax™, Boston Scientific, Natick, MA) up to 18-atmosphere pressure, using an inflator (Leveen™ Inflator, Boston Scientific), and a 30-F Amplatz sheath (Amplatz sheat, Boston Scientific) was placed over the inflated Nephromax™.

Nephroscopy was performed with a rigid, 26-F nephroscope. Fragmentation of the stone burden was accomplished using a pneumatic lithotriptor (Vibrolith, Elmed). Additional tracts were created when indicated in the same session. Stone clearance and the integrity of the collecting system were confirmed intraoperatively by fluoroscopy and antegrade nephrostography. At the end of the procedure, a 14-F nephrostomy tube was placed. The duration of PNL was also recorded.

Follow-up included routine radiological imaging studies. The procedure was considered successful if the patient was either free of stones or had only clinically insignificant residual fragments (CIRFs). Results were classified as ‘stone-free,’ presence of ‘clinically insignificant residual fragments (CIRF),’ and ‘unsuccessful (presence of residual stones)’ at the 3rd month of the follow-up. CIRFs were considered as $\leq$4 mm, non-obstructing, non-infectious, and asymptomatic residual fragments.

For statistical analysis, the SPSS program for Windows was used. Numeric data were expressed as mean $\pm$ standard deviation. *P* values less than 0.05 were accepted as statistically significant. Two groups were compared with paired Student’s *t*-test or Mann–Whitney *U* tests when necessary. Chi-square test with Yates correction and Fisher’s exact test were used for 2 $\times$ 2 contingency tables when appropriate for non-numerical data. Correlations between numeric and ordered parameters were analyzed with Pearson or Spearman’s rho correlation test, respectively. Groups were compared with Student’s *t*-test or analysis of variance (ANOVA) as necessary.

Results

A total of 711 patients (64 in GG, mean age: 70.4 $\pm$ 4 years; 647 in NGG, mean age: 40.9 $\pm$ 12.7 years) was included in the study. Demographic and biochemical data are shown in Table 1 and 2.

All preoperative parameters (urea, creatinine, eGFR, hemoglobin, and hematocrit) had statistically

Table 1 Demographic and preoperative laboratory data and the ratio of (postoperative to preoperative) estimated glomerular filtration rates of both groups

		Geriatric group (n = 64)	Non-geriatric group (n = 647)	P-value
Age (years)		70.4 ± 4.2	40.9 ± 12.7	<0.001
Female/male		33/31	267/380	0.07
Preoperative urea (mg/dl)		32.5 ± 14.5	25.7 ± 14.0	<0.001
Preoperative creatinine (mg/dl)		1.22 ± 1.09	0.98 ± 0.37	0.035
Preoperative hemoglobin (g/dl)		13.4 ± 1.70	13.9 ± 1.78	0.032
eGFR ratio (post-/preoperative)		1.13 ± 1.00	0.98 ± 0.20	0.133
Duration of operation (min)		55.7 ± 13.6	61.3 ± 20.9	0.036
Diameter of stone (mm)		10.08 ± 6.5	8.28 ± 5.54	0.037
Hydronephrosis (no. of patients)	None	1	27	0.659
	Grade 1	21	209	
	Grade 2	34	312	
	Grade 3	8	99	
Outcome (no. of patients)	Unsuccessful	0	0	0.020
	CIRF	19	103	
	REST	8	88	
	SF	37	456	

eGFR: Estimated glomerular filtration rate

CIRF: Clinically insignificant residual fragments, REST: residual fragments, SF: stone-free

Table 2 The laboratory values of the geriatric and non-geriatric groups before and after the intervention

		Preoperative	Postoperative	P-value
Urea (mg/dl)	Geriatric group	32.5 ± 14.5	31.0 ± 14.3	<0.001
	Non-geriatric group	25.7 ± 14.0	24.5 ± 12.6	<0.001
Creatinine (mg/dl)	Geriatric group	1.22 ± 1.09	1.08 ± 0.44	<0.001
	Non-geriatric group	0.98 ± 0.37	1.06 ± 0.75	<0.001
eGFR (ml/min)	Geriatric group	70.6 ± 23.0	71.6 ± 22.3	<0.001
	Non-geriatric group	112.3 ± 36.3	108.5 ± 36.1	<0.001
Hemoglobin (g/dl)	Geriatric group	13.4 ± 1.70	11.7 ± 1.85	0.02
	Non-geriatric group	13.9 ± 1.77	11.9 ± 2.02	<0.001
Hematocrit (%)	Geriatric group	38.8 ± 4.5	34.3 ± 4.9	<0.001
	Non-geriatric group	40.3 ± 4.8	34.9 ± 5.0	<0.001

eGFR: Estimated glomerular filtration rate

significant changes in the postoperative period. eGFR ratio (post-/preoperative) was 1.13 ± 1.00 in GG and 0.98 ± 0.20 in NGG ($P = 0.001$). The mean eGFR increased 13% in GG and decreased 2% in NGG during the postoperative period.

Although the mean stone diameter was greater in GG than NGG (10.08 ± 6.5 mm, 8.28 ± 5.54 mm, respectively, $P = 0.037$), the mean duration of the operation was shorter in GG than NGG (55.7 ± 13.6 min and 61.3 ± 20.9 min, respectively, $P = 0.036$).

Grade of hydronephrosis was not different between GG and NGG (Table 1). The outcomes of the PNL are given in Table 3. The rate of CIRF was statistically higher in GG than NGG [19 patients (29.6%), 103 patients (15.9%), respectively, $P = 0.020$]. There was no significant correlation between age groups with grade of hydronephrosis, duration of the operation and post-/preoperative creatinine ratio in correlation analyses.

Table 3 The cross tabulation of outcomes of both groups

		Group		Total
		Geriatric	Non-geriatric	
Outcome	CIRF	19	103	122
	REST	8	88	96
	SF	37	456	493
Total		64	647	711

CIRF: Clinically insignificant residual fragments, REST: residual fragments, SF: stone-free

Discussion

Although invasive treatment options for urinary stones may recover urinary anatomy and improve renal function, it may also have some potential risks, such as deterioration of renal function due to the operation and anesthesia [3]. Renal functional impairment is expected to be higher in the geriatric patient population due to the age-related lower basal renal function in this group. However, in the present study, neither group showed marked deterioration of renal function (Tables 1 and 2), and, further, recovery of the renal function was observed in GG. The eGFR ratio (post-/preoperative) was better in the GG than the NGG. In fact, mean eGFR increased 13% in GG and decreased 2% in NGG in the postoperative period.

In the literature, there are some studies showing protective effects of PNL on renal function in all age groups. In a study of patients who underwent percutaneous renal stone removal, Eshghi et al. [5] showed with renal scintigraphy that there was not any significant effect of PNL on renal function in the the postoperative period. Although we studied renal functional changes in the early postoperative period, Geterud et al. [6] demonstrated that there was no significant change of function using 51Cr-EDTA-clearance and gamma camera renography with 99mTc-DTPA before and 2 weeks to 5 months after percutaneous renal stone extraction. Similarly, Tasca et al. [7] illustrated that renal function had remained unchanged with respect to the preoperative values 4–7 days after PNL.

It has been shown that PNL does not result in loss of renal function even when treating complex renal calculi [8]. In a multicenter French study of patients over 70 years old, it has been shown that PNL was a safe and reliable technique that achieved a stone-free rate of 70.8% for all types of stones and did not affect postoperative serum creatinine and hemoglobin levels [9]. Similarly, we demonstrated that the eGFR increased 13% in GG in early postoperative period.

In another study of PNL conducted by Sahin et al. [10], no significant complication was observed in a group of patients older than 60 years, and no renal deterioration was detected even in the follow-up. Moreover, in the same study, the success rates (stone-free patients and patients with residual stones <4 mm) were similar, being 89% for the elderly group and 92% for the younger patients ($P = 0.718$). Although, in our study, the mean stone diameter of the GG was significantly greater than NGG (10.08 ± 6.5 mm and 8.28 ± 5.54 mm, respectively), the mean duration of the operation was shorter in GG than NGG (55.7 ± 13.6 min and 61.3 ± 20.9 min, respectively). So, the shorter duration of the operation may explain why the GG showed a better recovery of eGFR than NGG.

Perioperative and postoperative fluid administration might result in a significant decrease of hematocrit, hemoglobin, and urea levels in both groups during the postoperative period (Table 2). This also may contribute to the difference of eGFR in the two groups. However, we have no data regarding the amount of fluid given to the patients in the perioperative period.

Although the grade of hydronephrosis was not different between groups, outcomes were different. The rate of CIRF was statistically higher in GG than NGG [19 patients (29.6%), 103 patients (15.9%), respectively]. The relatively short duration of the operation in the geriatric group and the diversity of perioperative and postoperative care of these two groups may explain this difference.

Conclusion

PNL does not worsen the renal function in the geriatric and non-geriatric patients. Moreover, geriatric patients may benefit more from PNL than non-geriatric patients.

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