Urolithiasis
DOI 10.1007/s00240-014-0742-4

ORIGINAL PAPER

Does aging affect the outcome of percutaneous nephrolithotomy?

Ibrahım Buldu · Abdulkadir Tepeler · Tuna Karatag · Mehmet Nuri Bodakci · Namık Kemal Hatipoglu · Necmettin Penbegul · Tolga Akman · Okan Istanbulluoglu · Abdullah Armagan

Received: 28 August 2014 / Accepted: 4 November 2014

Abstract To investigate whether aging affects surgical outcomes by comparing the results of two patient groups undergoing PNL: those over 60 and those under 60. A retrospective screen was made for patients undergoing conventional PNL surgery for renal stones performed in two separate centers between 2010 and 2013. 520 patients included were classified into age groups: patients aged 18–59 comprised Group-1 and those aged over 60 comprised Group-2. Those between 60–69 years (sexagenarian) were assigned to Group-2a; 70–79 years (septuagenarian) to Group-2b; and 80–89 years (octogenarian) to Group-2c. Patients' demographic characteristics (accompanying comorbidities, ASA scores, body mass indices and stone size) and perioperative values (duration of surgery and hospital stay, success and complication rates) were compared between the groups. Mean stone size was similar in groups (30.1 ± 15.5 vs. 31.5 ± 15.4 mm, $p = 0.379$). The mean ASA value for the patients in Group-1 was 1.61; significantly lower than that in the other groups ($p = 0.000$). The level of accompanying comorbidities in Group-1 was significantly lower than that of the other groups ($p = 0.000$). The mean duration of surgery, postoperative hematocrit drop, complication and success rate were statistically similar in Groups 1 and 2 ($p = 0.860$, $p = 0.430$, $p = 0.7$, and $p = 0.66$, respectively). The duration of hospital stay was significantly shorter in the patients in Group-1 compared to those in Group-2 ($p = 0.008$). In experienced hands, PNL can be safely and reliably performed in the treatment of renal stones in elderly patients.

Keywords Kidney stone · Aging · Percutaneous nephrolithotomy · Outcome

Abbreviations

PNL	Percutaneous nephrolithotomy
URS	Ureteroscopy
SWL	Shockwave lithotripsy
WHO	World Health Organization
US	Ultrasonography
IVU	Intravenous urography
CT	Computed tomography
KUB	Kidney Ureters and Bladder radiography

Introduction

The first choice of treatment option for kidney stones greater than 2 cm in size is percutaneous nephrolithotomy (PNL). PNL with flexible ureterorenoscopy (URS) is also an option in symptomatic lower pole stones smaller than 2 cm that do not respond to shockwave lithotripsy (SWL) [1]. With increasing experience and advances in technology, PNL is now safely and effectively applied in even the most difficult cases. Cases involving pediatric and elderly patients and/or anatomical anomalies and comorbidities are regarded as challenging and have been the subjects of detailed studies [2–10].

According to World Health Organization (WHO) data, the number of individuals over 60 years of age is expected to rise

I. Buldu (✉) · T. Karatag · O. Istanbulluoglu
Department of Urology, School of Medicine, University of Mevlana, Konya, Turkey
e-mail: ibrahimbuldu@yahoo.com

A. Tepeler · T. Akman · A. Armagan
Department of Urology, Faculty of Medicine, Bezmialem Vakif University, Istanbul, Turkey

M. N. Bodakci · N. K. Hatipoglu · N. Penbegul
Department of Urology, Faculty of Medicine, Dicle University, Diyarbakir, Turkey

Published online: 14 November 2014

from 11 % of the world population to 22 % between 2000 and 2050, reaching a figure of 2 billion. A fourfold increase in the number of individuals aged between 80 and 90 is also expected (395 million) [11]. Aging causes significant changes in body physiology and increased levels of accompanying chronic disease. The number of elderly patients with renal stones seen in urological practice is rising in proportion to the increasing elderly population. Only a limited number of studies have been performed on the effectiveness and reliability of PNL in the elderly patient population [5–9, 12–14].

The purpose of this study was to investigate whether aging affects surgical outcomes by comparing the results of two patient groups undergoing PNL: those over 60 and those under 60.

Materials and methods

A retrospective screen was made for patients undergoing conventional PNL surgery for renal stones performed by experienced urology teams in three separate centers between October 2010 and May 2013. Children under 18 years of age were excluded. Five-hundred and twenty patients included were classified into age groups: patients aged 18–59 comprised Group 1 and those aged over 60 comprised Group 2. Those between 60 and 69 years (sexagenarian) were assigned to Group 2a; 70 and 79 years (septuagenarian) to Group 2b; and 80 and 89 years (octogenarian) to Group 2c. Patients' demographic characteristics (accompanying comorbidities, ASA scores, body mass indices and stone size) and perioperative values (duration of surgery and hospital stay, success and complication rates) were compared between the groups.

Anamnesis including detailed medical history, physical examination, urine tests and culture, blood count, serum biochemistry tests and coagulation tests were performed for all patients. Radiography of kidneys, ureters and bladder (KUB), urinary ultrasonography (US), intravenous urography (IVU) and/or computerized tomography (CT) were done as imaging techniques. Stone dimension was calculated by measuring the longest axis of stone on image. Total length was calculated for multiple stones.

Surgical technique

With each patient in the lithotomy position under spinal or general anesthesia, an open-ended 6Fr urethral catheter was first inserted with cystoscopy. The patient was then placed in the prone position. Opaque material was administered through the urethral catheter under C-arm fluoroscopy, and an 18G needle was safely inserted into the calyx. Following the insertion of a guide wire into the collecting system, the tract was dilated up to 30Fr with an Amplatz dilator. The nephroscopy was done using a 26 °F optic. The stones were fragmented with the assistance of a pneumatic and/or ultrasonic lithotripter. The fragments were extracted using forceps. After evaluation of stone clearance with fluoroscopy and nephroscopy, a nephrostomy catheter was placed for renal drainage.

The patients were assessed with laboratory tests and KUB postoperatively. The nephrostomy catheter was removed on days 1–3, postoperatively, and the patients were discharged. In the case of patients with a DJ stent, the catheter was removed after 15 days postoperatively. Patients were assessed with KUB and biochemical tests on day 1, postoperatively. Final stone-free status was assessed using CT on the 4th week control visit.

Statistical analysis

Data were analyzed on SPSS version 20 software. The *t* test, Mann–Whitney *U* test and Kruskal–Wallis test were used for statistical analysis. Statistical significance was investigated for demographic and operative data between the groups. Significance was set at $p < 0.05$.

Results

The mean age of the 520 patients in the study (181 women, 339 men) was 49.7 ± 13.6 (19–88 years). Group 1 consisted of 395 patients and Group 2 of 125. Mean age in Group 1 was 44.1 ± 10 years, compared to 67.3 ± 6.8 years in Group 2. Mean stone size was 30.1 ± 15.5 (10–96) mm in Group 1 and 31.5 ± 15.4 (10–90) mm in Group 2 ($p = 0.379$). Mean BMI values were 28.0 ± 4.6 (18.9–46.1) in Group 1 and 29.1 ± 4.9 (17–47.9) in Group 2 ($p = 0.030$). Demographic characteristics for the patient groups are summarized in Table 1.

The mean ASA value for the patients in Group 1 was 1.61: significantly lower than that in the other groups (1.96 in Group 2a, 2.39 in Group 2b and 2.46 in Group 2c) ($p = 0.000$). The ASA value of the patients in Group 2a was also significantly lower than that of the patients in Groups 2b and 2c ($p = 0.017$ and $p = 0.033$). There was no difference, in terms of ASA values, between Groups 2b and 2c ($p = 0.778$) (Fig. 1).

Comorbidities such as hypertension, diabetes mellitus and chronic obstructive pulmonary disease were observed at a level of 52.1 % in Group 1, compared to 88 % in Group 2 as a whole. At least one of these comorbidities was observed in 85.6 % of the patients in Group 2a, 91.3 % of those in Group 2b and 100 % of those in Group 2c. The level of accompanying comorbidities in Group 1 was significantly lower than that of the other groups ($p = 0.000$).

The mean duration of surgery in Groups 1 and 2 was 62.6 ± 31.1 min and 62.1 ± 31.7 min, respectively

Table 1 The demographics of the patients classified according to the age

	Overall	Group 1	Group 2	p^a	Group 2a	Group 2b	Group 2c	p^b
N (%)	520	395 (76)	125 (24)		89 (17.1)	23 (4.4)	13 (2.5)	
Mean age (years)	49.7 ± 13.6	44.1 ± 10	67.3 ± 6.8	0.000	63.5 ± 2.9	74.3 ± 2.7	83.2 ± 1.2	0.000
Sex (%)								
Male	339 (65.2)	269 (68.1)	70 (56)		54 (60.7)	10 (43.5)	6 (46.1)	
Female	181 (34.8)	126 (31.9)	55 (44)		35 (39.3)	13 (56.5)	7 (53.9)	
BMI	28.3 ± 4.7	28.0 ± 4.6	29.1 ± 4.9	0.030	29.6 ± 4.9	28.7 ± 4.9	26.4 ± 4.2	0.017
Comorbidity (%)				0.000				0.000
Yes	316 (60.8)	206 (52.1)	110 (88)		76 (85.6)	21 (91.3)	13 (100)	
No	204 (39.2)	189 (47.9)	15 (12)		13 (14.4)	2 (8.7)	0	
Side (%)				0.498				0.202
Right	230 (44.2)	178 (45.1)	52 (41.6)		39 (43.8)	11 (47.8)	2 (15.4)	
Left	290 (55.8)	217 (54.9)	73 (58.4)		50 (56.2)	12 (52.2)	11 (84.6)	
Stone size (mm)	30.46 ± 15.5	30.1 ± 15.5	31.5 ± 15.4	0.379	32.1 ± 16.9	30.3 ± 12.7	29.7 ± 8.2	0.596
ASA Score (%)								
Mean	1.73 ± 0.76	1.61 ± 0.73	2.10 ± 0.75	0.000	1.96 ± 0.79	2.39 ± 0.58	2.46 ± 0.51	0.000
1	242 (46.6)	212 (53.7)	30 (24)		29 (32.6)	1 (4.3)	0	
2	176 (33.8)	123 (31.1)	53 (42.4)		34 (38.2)	12 (52.2)	7 (53.8)	
3	102 (19.6)	60 (15.2)	42 (33.6)		26 (29.2)	10 (43.5)	6 (46.2)	
Stone multiplicity (%)				0.279				0.241
Single	248 (47.7)	181 (45.8)	67 (53.6)		50 (56.2)	13 (56.5)	4 (30.7)	
Multiple	272 (52.3)	214 (54.2)	58 (46.4)		39 (43.8)	10 (43.5)	9 (69.3)	

[a] *p* value (Group 1–2)

[b] *p* value (Group 1–2a–2b–2c)

($p = 0.860$). No significant difference was observed in the duration of surgery in the three subgroups ($p = 0.524$). Mean postoperative decreases in hematocrit values were 5.2 ± 3.5 and 4.9 ± 3.3, respectively ($p = 0.430$).

Complications developed in a total of 94 patients. The level of complications was 17.7 % in Group 1 and 19.2 % in Group 2 ($p = 0.7$). Minor complications (Clavien 1–2) were observed in 11.1 % and major complications (Clavien 3A–3B) in 6.6 % of patients in Group 1. The levels for Group 2 were 15.2 and 4 %, respectively. Levels of major and minor complications between the two main groups were similar ($p = 0.146$).

The duration of hospital stay was significantly shorter in the patients in Group 1 compared to those in Group 2 ($p = 0.008$). However, no significant difference ($p = 0.340$) was observed between the three elderly patient subgroups: 2A, 2B and 2C. Levels of stone-free status were 83.3 % and 81.6 % in Groups 1 and 2, respectively ($p = 0.66$). Patients' operative data and outcomes are shown in Table 2.

Discussion

Aging causes the body to experience morphological and functional changes. Sensitivity in the aging body increases in association with genetic characteristics, environmental factors, accompanying chronic diseases and types of medications used; difficulties are also experienced in adaptation to environmental changes. Surgery in elderly patients, who generally have several health problems and impaired homeostasis, may give rise to a range of complications and problematical outcomes [15–17].

Aging is reported to be one of the main factors affecting perioperative and postoperative morbidity. Decreased cardiopulmonary reserve, or tolerance of complications such as hemorrhage or sepsis, increases the risks of anesthesia [16]. Different age thresholds have been applied in age-related studies. Many studies regard 65 or 70 year olds as "elderly," while the United Nations considers people over 60 to be elderly [7]. In this study of renal stones treated with PNL, we divided patients aged 60 and above into three subgroups for comparison purposes.

In 1994, Stoller et al. [5] were the first to compare patients receiving PNL in terms of age groups (>65 years and <65 years). Levels and sizes of staghorn stones were similar, and while PNL was regarded as a safe and effective method in the elderly patient group (*n*: 33), blood transfusion requirements rose significantly in those patients. Researchers in later years (6, 13) investigated the efficacy and safety of PNL in elderly patients using limited patient

Table 2 Perioperative and postoperative outcomes in groups are summarized

	Overall	Group 1	Group 2	p^a	Group 2a	Group 2b	Group 2c	p^b
Operative time (minutes)	62.5 ± 31.3	62.6 ± 31.1	62.1 ± 31.7	0.86	61.3 ± 33.0	62.1 ± 31.5	67.3 ± 22.6	0.52
Hematocrit drop (%)	5.1 ± 3.5	5.2 ± 3.5	4.9 ± 3.3	0.43	5.0 ± 3.5	4.5 ± 3.0	5.7 ± 3.1	0.6
Postoperative catheterization (%)				0.3				0.81
Nephrostomy	468 (90)	354 (89.6)	114 (91.2)		80 (89.9)	22 (95.6)	12 (92.3)	
Tubeless	52 (10)	41 (10.4)	11 (8.8)		9 (10.1)	1 (4.4)	1 (7.7)	
Complications (%)				0.71				0.72
Yes	94 (18.1)	70 (17.7)	24 (19.2)		15 (16.8)	6 (26)	3 (23.1)	
No	426 (81.9)	325 (82.3)	101 (80.8)		74 (83.2)	17 (74)	10 (77)	
Clavien category (%)								
1	25 (4.8)	14 (3.5)	11 (8.8)		2 (2.2)	3 (13)	2 (15.4)	
2	38 (7.3)	30 (7.6)	8 (6.4)	0.146	8 (9)	3 (13)	1 (7.7)	0.177
3A	27 (5.2)	22 (5.6)	5 (4)		5 (5.6)	0	0	
3B	4 (0.8)	4 (1)	0		0	0	0	
Stone free (%)				0.66				0.93
Yes	431 (82.9)	329 (83,3)	102 (81.6)		73 (82)	18 (78.3)	11 (84,6)	
No	89 (17.1)	66 (16.7)	23 (18.4)		16 (18)	5 (21.7)	2 (15.4)	
Mean hospital stay (days)	2.0 ± 1.5	1.9 ± 1.7	2.3 ± 1.2	0.008	2.2 ± 1.2	2.7 ± 1.1	2.8 ± 0.8	0.000
Number of access (%)				0.69				0.55
Single	497 (95.6)	380 (96.2)	117 (93.6)		81 (91.1)	23 (100)	12 (92.3)	
Multiple	23 (4.4)	15 (3.8)	8 (6.4)		8 (8.9)	0	1 (7.7)	
Puncture site (%)				0.69				0.43
Upper	36 (6.9)	24 (6.1)	12 (9.6)		6 (6.7)	4 (17.4)	1 (7.7)	
Middle	142 (27.3)	119 (30.1)	23 (18.4)		17 (19.1)	5 (21.7)	2 (15.4)	
Lower	334 (64.3)	246 (62.3)	88 (70.4)		64 (71.9)	14 (60.9)	10 (76.9)	
Multiple	8 (1.5)	6 (1.5)	2 (1.6)		2 (2.3)	0	0	

[a] *p* value (Group 1–2)

[b] *p* value (Group 1–2a–2b–2c)

numbers, and obtained results similar to those in young patients.

Recently, Okeke et al. [12] used the CROES Global PNL database to compare peri and postoperative data from patients over 70 years of age with those from younger patients. Three-hundred and thirty-four patients over 70 were matched with a patient aged 18–70. Comorbidity levels ($p < 0.001$), particularly diabetes mellitus and cardiovascular diseases, and ASA scores ($p < 0.001$) were high in the elderly patient group, and these patients were found to require more medications (anticoagulants and prednisone). Despite mean stone sizes being similar, a greater level of staghorn stones was found in the elderly group. Success and complication levels were similar in the unmatched samples. In the matched samples, however, complication levels were higher in the elderly patient group compared to the younger patient group (19.9 vs. 6.6 %, $p < 0.001$). Despite the increased use of anticoagulants, the level of blood transfusion in the elderly group was similar to that in the younger patient group. The length of hospitalization

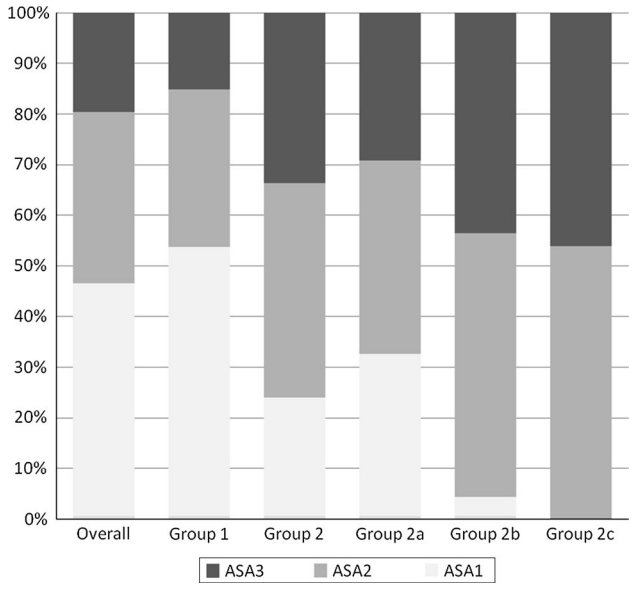

Fig. 1 The distribution of patients in each age group according to the ASA scores

was significantly prolonged in the elderly patient group ($p < 0.001$). The duration of surgery, stone size, number of surgical access points, stone-free and complication rates were similar between our patient groups, while the presence of comorbidity, ASA score and BMI was statistically different. The length of hospital stay was significantly greater in Group 1 compared to Group 2. We believe that this difference may be related to the cultural reasons. In our country, the elderly patients do want to discharge from hospital unless they feel very well.

Resorlu et al. [7] investigated data for 283 patients aged ≥60 years, dividing these into three groups on the basis of Charlson comorbidity index (CCI) scores (CCI score 0, 1 and ≥2) and determined postoperative complications in 27.2 % of patients. Of these, 25.4 % required medical intervention and 13.4 % were serious complications requiring surgery. They observed that PNL represented a reliable alternative in the conservative treatment of patients with large, asymptomatic renal stones. In our study, the complication level in the elderly population was 19.2 %, the majority (15.2 %) being minor complications requiring medical treatment. The level of major complications requiring surgical treatment was quite low, at 4 %.

The main limitations of this study are that it was retrospective and multi-centered. Small sample size may be regarded as other limitation factor. A strength of this study, in contrast to others in the literature, is that elderly patients were divided into 6th, 7th and 8th decade age groups. This study showed that PNL could be applied with similar success and complication rates in patients in the aforementioned groups.

Conclusion

As the elderly population grows, it is highly probable that larger numbers of elderly patients will be seen in urological practice and will require surgery for renal stones. The main problems in this patient group are systemic diseases and changing body physiology. In experienced hands, PNL can be safely and reliably performed in the treatment of renal stones in elderly patients with no increased rates of success and complication.

Conflict of interest None.

References

1. Turk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub M, Seitz C (2013) Selection of procedure for active removal of kidney stones. EUA Guidelines on Urolithiasis, pp 46–48
2. Rana AM, Bhojwani JP (2009) Percutaneous nephrolithotomy in renal anomalies of fusion, ectopia, rotation, hypoplasia, and pelvicalyceal aberration: uniformity in heterogeneity. J Endourol 23:609–614
3. Gupta N, Mishra S, Seth A, Anand A (2009) Percutaneous nephrolithotomy in abnormal kidneys: Single-center experience. Urology 73:710–714
4. Schuster TK, Smaldone MC, Averch TD, Ost MC (2009) Percutaneous nephrolithotomy in children. J Endourol 23:1699–1705
5. Stoller ML, Bolton D, St Lezin M, Lawrence M (1994) Percutaneous nephrolithotomy in the elderly. Urology 44:651–654
6. Sahin A, Atsü N, Erdem E, Oner S, Bilen C, Bakkaloglu M, Kendi S (2001) Percutaneous nephrolithotomy in patients aged 60 years or older. J Endourol 15(5):489–491
7. Resorlu B, Diri A, Atmaca AF, Tuygun C, Oztuna D, Bozkurt OF, Unsal A (2012) Can we avoid percutaneous nephrolithotomy in high-risk elderly patients using the Charlson comorbidity index? Urology 79(5):1042–1047
8. Nakamon T, Kitirattrakarn P, Lojanapiwat B (2013) Outcomes of percutaneous nephrolithotomy: comparison of elderly and younger patients. Int Braz J Urol 39:692–701
9. Kuzgunbay B, Turunc T, Yaycioglu O, Kayis AA, Gul U, Egilmez T, Aygun C, Ozkardes H (2011) Percutaneous nephrolithotomy for staghorn kidney stones in elderly patients. Int Urol Neph 43:639–643
10. Dogan HS, Tekgul S (2012) Minimally invasive surgical approaches to kidney stones in children. Curr Urol Rep 13:298–306
11. WHO (2013) Ageing and life course. http://www.who.int/ageing/en/index.html.19.09.2013
12. Okeke Z, Smith AD, Labate G, D'Addesi A, Venkatesh R, Assimos D, Stijbos WE, de la Rosette JJ, CROES PCNL Study Group (2012) Prospective comparison of outcomes of percutaneous nephrolithotomy in elderly patients versus younger patients. J Endourol 26:996–1001
13. Anagnostou T, Thompson T, Ng C-F, Moussa S, Smith G, Tolley DA (2008) Safety and outcome of percutaneous nephrolithotomy in the elderly: retrospective comparison to a younger patient group. J Endourol 22:2139–2146
14. Akbari NR (2007) Percutaneous nephrolithotripsy complication in the elderly. Aging Male 10:77–87
15. Tonner PH, Kampen J, Scholz J (2003) Pathophysiological changes in the elderly. Best Pract Res Clin Anaesthesiol 17:163–177
16. Priebe H (2000) The aged cardiovascular risk patient. Br J Anaesth 85:763–778
17. Sieber FE (2009) Postoperative delirium in the elderly surgical patient. Anesthesiol Clin 27:451–464