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ORIGINAL ARTICLE

Active stone removal is a safe option for ocotogenarians and nonagenarians with nephrolithiasis

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Abstract

Purpose To assess the contemporary in-hospital management of octogenarians and nonagenarians with renal calculi.

Material and Methods A multicentric retrospective evaluation of patients aged ≥ 80 years hospitalized with kidney stones between 01/2000 and 12/2019. Stone and patient related data were collected, including stone size and location, geriatric status and comorbidities. Surgical treatment patterns and outcome were assessed.

Results A total of 299 patients (57% female) with kidney stones were analyzed. Mean age was 84.7 years. Patients were largely multimorbid (ASA ≥ 3 in 70%) and about 25% were classified as frail. Active stone treatment was performed in 65% and 35% were treated with urinary diversion (stent or nephrostomy). Prognostic factors for receiving an active stone treatment were age < 90 years, male sex, stone size and quantity, and performance status. Mean overall survival was 23.7 months and when stratified to treatment mean survival were 21 months after urinary diversion, 28 months after URS, 29 months after PCNL and 45 months after SWL.

Conclusion Age, frailty and performance-status as well as stone size and quantity are predictors for active stone treatment. Octogenarians and nonagenarians, who are considered fit for surgery, tend to live long enough to profit from active stone treatment.

Keywords Nephrolithiasis · Geriatric patients · Kidney stones · Nonagenarians · Octogenarians · Outcome · Elderly patients

Introduction

Kidney stones are a common disorder, affecting all age groups and sexes, with a prevalence of about 10% in the developed world [1] and an overall increasing incidence

A joint study by the endourological section of the Austrian Association of Urology.

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[2]. Due to demographic changes and a rising life expectancy, the fastest growing population is the age group of 80 years and older [3]. Consequently, an increase of geriatric stone patients can be expected [4, 5].

Elective and emergency surgery for urolithiasis in this cohort is associated with an increased morbidity and mortality compared to younger patients [6, 7].

Although guidelines provide high-level evidence and treatment algorithms for stone patients [8], the management of very old and frail patients with urolithiasis is not explicitly addressed, as only few reports concerning the optimal management of urolithiasis in this cohort are available [9–14]. Thus, stone treatment in octogenarians and nonagenarians follows the same recommendations and standards as for younger patients and treatment decisions in this cohort are often driven by clinical experience and patient's performance status [8].

In this study, we investigated the contemporary management of patients with renal stones, aged 80 or older, in a multicentric setting.

Material and methods

After institutional review board approval, clinical records of all patients aged ≥ 80 years, that were hospitalized due to nephrolithiasis, were retrospectively evaluated. Data from 8 Austrian urological centers between 1.1.2000 and 31.12.2019 were extracted. The study is a joint project of the endourological task force of the Austrian Association of Urology (ÖGU).

Patient age, gender, comorbidities and stone related data were collected. Stone size and location were calculated from CT-scans. Comorbidities were assessed using the American Society of Anesthesiologists (ASA) score. The extent of frailty was classified as the absence of a walking aid, the need of a walking aid, e.g., crutches or cane, wheelchair or bedridden.

Stone treatment patterns were assessed, and stone-free rates (SFR) were extracted from surgical reports and/or from postoperative CT-scans. Predictors for active stone treatment were calculated, and overall and treatment-specific survival was evaluated.

Statistical analyses, including the Chi-square test, and the logistic regression analyses, were performed with SPSS, version 21 (IBM Corp, Armonk, NY). Multivariate logistic regression analyses were carried out with significant findings from univariate analyses to obtain independent prognostic factors influencing treatment decisions. A p value of < 0.05 was considered statistically significant.

Results

A total of 1067 hospitalizations related to urolithiasis in patients aged 80 years and above were noted during the study period. Out of those, 501 kidney stones and 759 ureteral stones were observed. Excluding patients with concomitant ureteral stones left a cohort of 299 hospitalizations with solely kidney stones, of which 215 received either active stone removal (SWL, URS, PNCL) or the placement of a ureteral stent or nephrostomy tube.

Patients with kidney stones were at average 84.7 years old. The majority of these patients were females (56.9%). Average stone size was 12.1 mm, and 50% of all patients had multiple kidney stones. Multiple kidney stones were more frequent in female patients (55.6%, $p = 0.02$).

Most patients were frail at least in some degree. The majority needed walking aids, and 25.8% of all patients needed a wheelchair or were even bedridden. The rate of female patients with reduced mobility (wheelchair or bedridden) was significantly higher (F: 35.6%, M: 9%, $p < 0.0001$).

Multiple comorbidities were noted among the study population, resulting in high ASA scores (≥ 3 in 69.1%). Female patients had significantly more comorbidities (ASA ≥ 3—F: 79%, M: 59%, $p = 0.002$) and had higher rates of dementia (F: 22.5%, M: 6.6%, $p < 0.0001$).

Further patient's demographics and characteristics are displayed in Table 1.

Procedures performed due to kidney stones during hospitalization were mainly DJ-stent placements ($n = 184$), whereas de-obstruction via nephrostomy was rarely done ($n = 8$). Concerning active stone treatment, SWL outnumbered flexible URS and PCNL ($n = 83$, 69 and 45, respectively). Among the procedures, significant differences were noted according to gender, age, stone size and stone burden (all $p < 0.0001$) (Table 2). Patients with bigger stones or multiple calculi were primarily treated with PCNL or were simply stented, whereas patients with smaller and singular stones were more frequently treated with SWL (Table 3).

Decision making for active stone treatment

In patients hospitalized in an elective, non-acute setting, decision making for either active stone treatment or simply keeping patients stented (after emergency de-obstruction) was further analyzed. To reduce the potential bias of capturing patients with concomitant ureteral calculi, only 215 patients with solely kidney stones were assessed (Table 3). Active stone treatment (flexible URS/SWL/PCNL) was done in 64.7%, whereas 35.3% of the procedures were

Table 1 Patient demographics

	n = or mean	% or min–max (SD)	p value*
Hospitalizations			
Kidney ± ureteral stones	501		
Solely kidney stones	299		
Gender			
Male	216	43.1%	< 0.0001
Female	285	56.9%	
Age (years)			
Total	84.7	80–98 (4.03)	
Male	83.7	80–96 (3.02)	
Female	85.4	80–98 (4.52)	
Nonagenarians	32	10.7%	
Male	3	2.4%	< 0.001
Female	29	16.3%	
Stone size < 1 cm			
Total	109	38%	
Male	55	46%	
Female	54	32%	
Stone size 1-2 cm			0.04
Total	134	46,7%	
Male	50	42%	
Female	84	50%	
Stone size > 2 cm			
Total	44	15,3%	
Male	14	12%	
Female	30	18%	
Stone burden (kidney) solitary			0.02
Total	150	50,1%	
Male	71	58,6%	
Female	79	44,4%	
Stone burden (kidney) multiple calculi			
Total	149	49,9%	
Male	50	41,4%	
Female	99	55,6%	
Stone location			< 0.0001
Upper pole	137/501	27.6%	
Middle pole	163/496	32.9%	
Lower pole	317/495	64%	
Pelvis	180/495	36.4%	
Indwelling catheter	88/476	18.5%	
Frailty			< 0.0001
Mobile	214/453	47.2%	
Walking aid	131/453	28.9%	
Wheelchair	28/453	6.2%	
Bedridden	80/453	17.7%	
Anticoagulation	225/501	44.9%	
Stroke	73/500	14.6%	
Diabetes	122/501	24.4%	
Myocardial infarction	24/501	4.8%	
Coronary heart disease	105/425	21%	

Table 1 (continued)

	n = or mean	% or min–max (SD)	p value*
Dementia			< 0.0001
Total	48/299	16%	
Male	8/121	6.6%	
Female	40/178	22.5%	
Custodianship	27/497	5.4%	0.002
ASA score 1–2			
Total	60	28%	
Male	33	40.7%	
Female	27	20.6%	
ASA score ≥ 3			
Total	152	72%	
Male	48	59.3%	
Female	104	79.4%	
Institutions			< 0.0001
LK Baden	137/501	27.3%	
Klinik Donaustadt	43/501	8.6%	
UK Innsbruck	12/501	2.4%	
LK Zell am See	58/501	11.6%	
Klinik Favoriten	54/501	10.8%	
UK Krems	86/501	17.2%	
LK Salzburg	97/501	19.4%	
LK Klagenfurt	14/501	2.8%	

SD standard deviation

*Chi-square test

replacements of DJ/PCN-tubes. Active stone treatment was more frequently done in men, patients under 90 years of age, in smaller stone burdens, as well as those being less frail and in absence of indwelling catheters (all $p < 0.005$, Table 3) Conversely, DJ/PCN changes on a regular basis were significantly more frequently performed in women, patients aged 90 years or older, in greater stone burdens, in case of dementia, in frail patients and in those with an indwelling catheter or under custodianship (all $p < 0.005$, Table 3).

Logistic regression analyses were done to further investigate these observations. In univariate analysis, gender, frailty, stone size, indwelling catheters, dementia (all $p < 0.0001$), age ($p = 0.01$), stone burden ($p = 0.005$) and custodianship ($p = 0.02$) influenced the chances of active stone treatment. Multivariate logistics analyses, corrected for significant results from univariate analyses, revealed that gender and stone size were independent predictors for treatment choice. Stones sized ≤ 10 mm were more than 15 times more likely to be actively treated than those > 20 mm (OR = 15.62, 95% CI 4.46–54.79, $p < 0.0001$). Male patients had 3 times higher chance of undergoing active stone treatment compared to women (OR 3.36 95% CI 0.14–8.06, $p = 0.007$).

Table 2 Management of hospitalized patients with renal calculi

	n =	Age (95% CI, SD)	Stone Size (95% CI, SD)	Multiple Calculi (n)	Gender (m/f)
DJ-stent	184	85.9 (80–87, 4.47)	15.6 (1–40, 9.67)	65.2% (120)	30.4%/69.6%
Nephrostomy	8	84 (81–87, 2.39)	9 (5–13, 2.39)	37.5% (3)	25%/75%
Flex. URS	69	83.8 (80–96, 3.32)	9.8 (2–40, 7.26)	50.7% (35)	37.7%/62.3%
SWL	83	84.1 (80–97, 3.85)	7.9 (2–25, 4.44)	28.9% (24)	54.2%/45.8%
PCNL	45	83.2 (80–88, 2.27)	17.6 (5–40, 8.22)	55.6% nn	62.2%/37.8%
p value		< 0.0001[a]	< 0.0001[a]	< 0.0001[b]	< 0.0001[b]

CI confidence interval, *SD* standard deviation

[a]Kruskal–Wallis test (independent samples)

[b]Chi^2 test

Table 3 Analysis of treatment choice

	Change of DJ/PCN	Active stone treatment (URS/SWL/PCNL)	p value (chi^2 test)
% (n)	35.3% (76/215)	64.7% (139/215)	–
Gender			< 0.0001
Male	15.9% (14/88)	84.1% (74/88)	
Female	48.8% (62/127)	51.2% (65/127)	
Age			0.007
< 90	32.5% (63/194)	67.5% (131/194)	
≥ 90	61.9% (13/21)	38.1% (8/21)	
Stone burden			0.004
Single	26.5% (30/113)	73.5% (83/113)	
Multiple	41.5% (46/143)	54.9% (56/143)	
Stone size			< 0.0001
< 10 mm	11.3% (9/80)	88.8% (71/80)	
10–20 mm	47.4% (46/97)	52.6% (51/97)	
> 20 mm	64.5% (20/31)	35.5% (11/31)	
Anticoagulation			0.5
Yes	37.8% (37/157)	62.2% (61/157)	
No	33.3% (39/127)	66.7% (78/127)	
Frailty			< 0.0001
Mobile	19.8% (16/81)	80.2% (65/81)	
Walking aid	30.3% (20/91)	69.7% (46/91)	
Wheelchair	41.7% (5/12)	58.3% (7/12)	
Bedridden	77.5% (31/40)	22.5% (9/40)	
Dementia			< 0.0001
Yes	73% (27/37)	27% (10/37)	
No	26.9% (45/167)	73.1% (122/167)	
Indwelling catheter			< 0.0001
Yes	67.4% (29/43)	32.6% (14/43)	
No	27.2% (44/162)	72.8% (118/162)	
Custodianship			0.02
Yes	62.5% (10/16)	37.5% (6/16)	
No	33% (65/197)	67% (132/197)	
ASA score			0.13
1	14.3% (1/7)	85.7% (6/7)	
2	30% (12/40)	70% (28/40)	
3	41.3% (50/121)	58.7% (71/121)	
4	75% (3/4)	25% (1/4)	
Diabetes			0.76
Yes	37% (20/54)	63% (34/54)	
No	34.8% (56/161)	65.2% (105/161)	
Myocardial infarction			0.67
Yes	42.9% (3/7)	57.1% (4/7)	
No	35.1% (73/208)	64.9% (135/208)	
Stroke			0.19
Yes	46.4% (13/28)	53.6% (15/28)	
No	33.7% (63/187)	66.3% (124/187)	

Outcomes of procedures

Highest stone-free rates (SFR) were noted with PCNL (68.9%), followed by flexible ureteroscopy (67.6%). The SFR of SWL were 21% in all and 27.4% in pre-stented patients. Length of hospital stay was considerably high, with 6.3 days after PCNL and even after minimally invasive procedures, such as flex. URS (4.7 days) or SWL (4.5 days).

No severe perioperative complications (Clavien ≥ III) were reported.

In flex. URS, a ureteric perforation occurred in three cases (4.3%) and all were managed with prolonged duration of indwelling ureteric stent.

One case of a proximal ureteral lesion occurred during PCNL, resulting in a ureter-stenosis, requiring permanent stenting.

Postoperative complications were mostly minor (Clavien < III) and included urinary tract infections, septicemia, hematuria, hematoma, stent incrustation and Steinstrasse.

Septicemia occurred in four patients after URS (5.8%), of whom two succumbed to the complication. Two patients developed urosepsis after SWL (2.4%) and one patient died subsequently.

One patient (2.2%) developed gross hematuria after PNCL and consequently required blood transfusions and two patients (2.4%) received blood transfusions due to hematoma after SWL.

Further, an incrusted stent after URS required SWL-treatment and respectively URS-lithotripsy and two patients (2.4%) developed Steinstrasse after SWL and were treated with ureteroscopic lithotripsy.

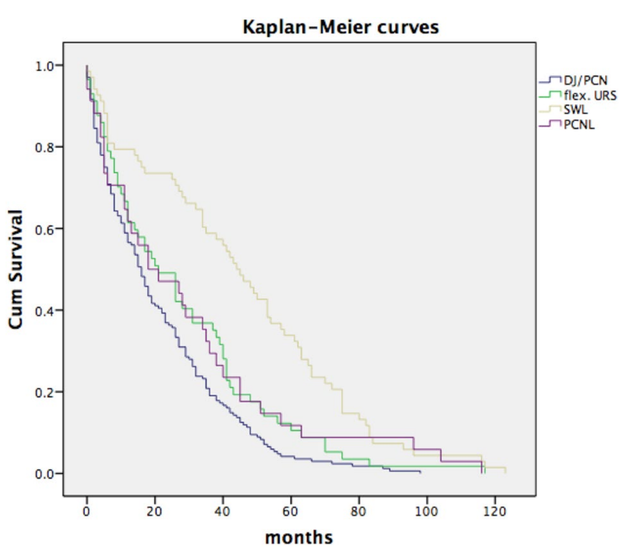

Fig. 1 Mean overall survival after intervention

Survival and death

Roughly half of the study population died during the investigated period (49.2%). Kaplan–Meier analyses were performed to estimate mean survival time after each procedure. Estimated survival times after DJ/PCN, flex. URS PCNL and SWL were 21.3, 28, 29.3 and 45.4 months, respectively. ($p < 0.0001$). Kaplan–Meier curves are displayed in Fig. 1.

Discussion

Demographic changes and a rising life expectancy will transform the field of urology, with an increasing number of geriatric patients requiring urological care and treatment [4]. Due to the lack of evidence-based guidelines for the management of elderly, particularly frail patients, case studies that report selectively on this cohort could offer valuable information for this diagnostic and therapeutic dilemma.

To our knowledge, studies evaluating elderly patients with renal calculi are rare [10, 12, 15] and we report herein on the largest series on octogenarians and nonagenarians with nephrolithiasis.

Our results must be interpreted in the context of the Austrian healthcare system, which is public, free of charge and has no restrictions to admission and length of hospitalization.

Approximately two-third of our study population received an active stone treatment. Patient age and frailty were significant predictors for the choice of stone management. Male patients, aged younger than 90, with smaller renal calculi and that were classified as less frail (ASA < 3), had a significantly higher likelihood to receive active stone treatment. Conversely, patients with a higher stone burden, female sex, an age of > 90 years, advanced frailty, a history of dementia and foley-catheter dependency were less likely to undergo active stone removal.

Frailty and advanced age are associated with higher complications in stone treatment [12, 15, 16]. This might explain the reluctance of active stone treatment for nonagenarians in our study population, as an age of ≥ 90 years was a relative threshold for active therapy in our series. Further, the female patients in our series were significantly older, frailer and had higher rates of dementia and comorbidities, thus reflecting in a lesser likelihood for females, to undergo active stone treatment.

Yamashita et al. report, in a comparable retrospective study, on renal stone management in patients with poor performance status, with a similar rate of active stone treatment (70%) and a significantly higher patient age (mean 86 years) in the conservative management group [15]. In contrast, Mager et al. found no differences in the choice of active or conservative renal stone treatment between patients aged > 80 years or 70–79 years, yet no nonagenarians were included in their series [12].

Stone size and stone burden had a significant impact on the choice between active stone treatment versus urinary diversion. Stone size and burden in the renal collective system are associated with decreased SFRs and patients with large and/or multiple renal calculi have a high risk of requiring additional interventions [17–19]. Thus, urinary drainage with stent or nephrostomy was favored in our series in old and frail patients with complex stones,

The influence of indwelling catheters on treatment decisions might be explained by the increased risk of urinary tract infections associated with catheters [20, 21] and the fact that patients with catheters are generally less healthy and have higher rates of functional dependency [22].

The highest stone-free rates (SFR) in our series were after PNCL (68.9%), followed by URS in pre-stented kidneys (67.7%). SFRs after shock wave lithotripsy were 27.4%.

In contrast to other studies, the SFRs after active stone treatment in our series were comparably low. Mager et al. report a SFR of 93% after PCNL (n = 14) and 91% after URS (n = 55), in patients aged > 80 years (n = 84) [12].

Morganstern et al. report SFR of 78% after PCNL in 36 patients who are > 80 years old and have multiple comorbidities [13]. Yamashita et al. describe a SFR of only 50% after PCNL in patients with poor performance status (mean age 82 years), yet the SFR after URS in their series was up to 87% [13].

Stone-free rates after SWL were 50% in the study of Yamashita [15] and 61% in the series of Mager et al. [12].

The rather modest SFR of SWL in our series is likely related to the limited in-hospital observation period in this retrospective analysis, as SWL in Austria is performed generally in an outpatient setting. The reason for the differences in SFR after PCNL and URS remains speculative and could be explained by differences in patient selection, case mix or sample sizes.

Consistent with the results of other studies on patients aged ≥ 80 [10, 12, 15], the major complications (Clavien–Dindo ≥ 3) in our series were rare, sepsis was observed in six cases, with two patients succumbing to sepsis.

Mean OS in our series was nearly 24 months, with significantly longer OS in patients that received active stone treatment (URS 28 months, PCNL 29 months and SWL 45 months), compared to patients that solely underwent urinary drainage by stent or nephrostomy tube (21 months).

In the series of Yamashita et al., the 2-years OS was 88% in the surgical-treatment group vs. 38% in the group of conservatively managed patients [15]. The group of urolithiasis-patients in the study of Mager et al. had a 2-years OS of 91% and a mean OS of 61 months. However, no nonagenarians were included in this study [12].

The negative effect of ureteral stents and nephrostomy tubes on quality of life has been previously described [23, 24]. Furthermore, patients left on permanent urinary diversions require regular visits to hospitals to get their DJ-stents or nephrostomy tubes replaced. This brings additional financial burden on health care systems. As we were able to demonstrate in our study, octogenarians who are fit for surgery do not have higher complications than their younger counterparts [9, 11] and tend to live longer than those octogenerians who are not fit for surgery. Therefore, we suggest active stone treatment in octogenarians with lower ASA and frailty scores in order to provide a better quality of life. In this patient group, decision making for surgical intervention can be similar to younger patients.

The major limitation of our study is its retrospective nature, the non-standardized management of elderly patients with nephrolithiasis and the absence of data from outpatient and office-based treatments. Despite these shortcomings, the data generated in our series may provide some guidance for the management of this challenging and ever-increasing cohort.

Conclusion

Age, frailty and performance status as well as stone size and stone burden are predictors for active stone treatment. Surgical stone treatment in geriatric patients with renal calculi is safe and with acceptable stone-free rates. Octogenarians and nonagenarians, who are considered fit for surgery, tend to live long enough to profit from active stone treatment.

Author contributions KE: data analysis and management, manuscript writing; MD: data collection, data analysis; MÖ: project development, manuscript revision; CW: project development, data collection; ML: data collection; CR: data collection; PS: data collection; JZ: data collection; CEF: data collection; IH: data collection; AW: data collection; SS: project development, data analysis and management, manuscript writing.

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Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants The paper does not report on primary research. All data analyzed were collected as part of routine diagnosis and treatment. The Ethics Committee of the City of Vienna waived the need for ethics approval and the need to obtain consent for the collection, analysis and publication of the retrospectively obtained and anonymized data for this non-interventional study.

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