

Epidemiologic and Clinical Characteristics of Patients Presenting with Renal Colic in Korea

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Purpose: To investigate the epidemiologic and clinical characteristics of renal colic in Korea.

Materials and Methods: Forty-six participating emergency departments provide their essential information to the National Emergency Medical Center. We extracted the National Emergency Department Information System data from January to December 2010. We analyzed data on demographics, visit time, chief complaints, mode of arrival, outcome, and length of stay. A total of 23,653 patients with renal colic visited the 46 emergency departments, and this patient population comprised 1.8% of all emergency department visits.

Results: The median patient age was 45 years, and the male-to-female ratio was 2:1. The peak time of incidence for patients with renal colic occurred between 06:00 and 10:00 h. The peak incidence occurred in August, whereas the lowest incidence occurred in winter. The most common chief complaint was flank pain, followed by abdominal pain and hematuria. The median length of stay in the emergency department was 171 min, and female patients stayed longer in the emergency department relative to male patients. The median length of stay was shorter for weekend visits than for weekday visits. Most patients were discharged from the emergency department; only 6% of patients were admitted. Monday was the day with the highest admission rate. The length of stay did not correlate with age, whereas the admission rate increased with age.

Conclusion: The epidemiologic and clinical features derived from this study may facilitate further investigations aimed at understanding the etiology of renal colic.

Keywords: colic; epidemiology; emergency service; incidence; kidney calculi; prevalence; Korea.

INTRODUCTION

Acute renal colic is the most frequent clinical presentation of urolithiasis and a common cause of patient visits to emergency departments (EDs) worldwide. The lifetime risk of urolithiasis is estimated to range from 5–12% in Europe and in the United States, affecting 13% of males and 7% of females in the population.^(1,2) Furthermore, the lifetime recurrence rate has been estimated to be as high as 50% within 10 years of the initial urolithiasis episode.⁽³⁾ Several prior studies have shown a worldwide trend toward an increasing prevalence and incidence of urolithiasis; this trend has also been observed in Korea.⁽⁴⁻⁶⁾ Given the high prevalence of urolithiasis, the total annual health care expenditure for urolithiasis in the United States was estimated to be 5 billion US dollars in 2009.⁽⁷⁾ Acute renal colic may be characterized by a sudden severe flank or lower back pain that may radiate down to the genitalia. Additional symptoms may include nausea, vomiting, and macroscopic or microscopic hematuria. The diagnosis of urolithiasis is generally based on the history, clinical symptoms, and physical examination. The need to evaluate the presence of a stone with radiologic imaging studies is controversial. Either intravenous urography or intravenous pyelogram has

traditionally been the preferred imaging study. Recently, there has been pressure in the international literature to obtain a non-contrast helical computed tomography (CT) scan of all patients.⁽⁸⁾ Most patients with acute renal colic can be managed conservatively with pain medication, hydration, and expected stone passage.⁽⁹⁾ Although the ED plays an important role in the diagnosis and management because patients present to the ED with renal colic, the epidemiologic and clinical data from EDs have been less well studied in Korea. The objectives of this study were to investigate the demographic, epidemiologic, and clinical characteristics of renal colic in EDs in Korea. We also analyzed several factors associated with hospital admission.

MATERIALS AND METHODS

Study Population and Variables

We conducted a retrospective observational study of patients with renal colic attack using the National Emergency Department Information System (NEDIS) of Korea, a nationwide electronic emergency medical care database. This system has operated since 2003, and information for the database is drawn annually from participating EDs. Information regarding all patients is automatically transferred from each hospi-

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Endourology and Stone Disease | 2148

Table 1. Demographic and clinical characteristics of patients with renal colic.

Descriptors	No. of Patients	Proportion (%)
All	23,653	100
Age group (years)		
18-44	11,750	49.7
45-64	9,871	41.7
≥ 65	2,032	8.6
Time of day (h)		
00:00-06:00	5,844	24.7
06:00-12:00	7,974	33.7
12:00-18:00	4,525	19.1
18:00-24:00	5,310	22.4
Season of year		
Spring	5,637	23.8
Summer	6,766	28.6
Autumn	5,966	25.2
Winter	5,284	22.3
Chief complaint		
Flank pain	14455	61.1
Abdominal pain	5426	22.9
Hematuria	374	1.6
Back pain	264	1.1
Other	3134	13.2
Modes of arrival		
Private ground transport	11,306	47.8
Walk-in	8,456	35.8
EMS ambulance	3,094	13.1
Other	797	3.4

Abbreviation: EMS, emergency medical service.

tal to a central server within 14 days of the patient's discharge from an ED or hospital ward. We evaluated all patients whose data were available in the NEDIS and who visited participating EDs from January 2010 to December 2010 (12-month period). A total of 46 EDs were included in this study. Renal colic attacks in patients visiting the ED were defined according to assignment of the following codes from the Korea Standard Classification of Disease, 6th Revision (KCD-6 codes): N132, N200-N203, and N210-N211. Because the incidence of renal colic attack was low among individuals younger than 18 years, we confined the data analysis to patients aged 18 years or older. We did not have data on the exact time of onset of the renal colic, but because in the participating regions it is considered good practice to present to the ED as soon as possible after flank or abdominal pain, we presumed that the patients visited the ED on the day of the renal colic attack. The analysis included the following variables: age,

Table 2. Length of stay in emergency departments of patients with renal colic.

Variables	Length of Stay (min)	P Value
Gender		< .001
Male	166 (119-244)	
Female	179 (130-265)	
Age group (years)		.808
18-44	171 (122-242)	
45-64	168 (121-250)	
≥ 65	174 (123-259)	
Time of day (h)		< .001
00:00-06:00	173 (120-271)	
06:00-12:00	177 (129-258)	
12:00-18:00	175 (123-246)	
18:00-24:00	158 (114-226)	
Day of week		<.001
Sunday	166 (121-235)	
Monday	178 (125-267)	
Tuesday	173 (122-252)	
Wednesday	175 (124-259)	
Thursday	169 (119-251)	
Friday	174 (123-262)	
Saturday	165 (120-240)	

gender, chief complaints, mode of arrival, arrival and departure times, ED diagnosis, and outcome of ED management. All patients were divided into 3 groups according to their age: 18-44, 45-64, and ≥ 65 years old. Additionally, patients were assigned to four 6-h time groups according to the ED visit time (00:00-06:00 h, 06:00-12:00 h, 12:00-18:00 h, and 18:00-24:00 h). The 12-month analysis period was divided into 4 seasons; spring (March to May), summer (June to August), autumn (September to November), and winter (December to February). Length of stay (LOS) was defined as the interval in minutes between the arrival time at the ED and the departure time from the ED. We also compared the number and rate of admissions according to each gender, age group, day of the week, and season.

Statistical Analysis

All data were processed using Microsoft Office Excel 2007 (Microsoft Corp., Redmond, WA, USA), and all statistical analyses were performed using the Statistical Package for the Social Science (SPSS Inc, Chicago, Illinois, USA) version 17.0. Continuous variables were expressed as medians (25-75% interquartile ranges [IQRs]), and the Kruskal-Wallis test was employed to compare nonparametric data. Categorical variables were expressed as frequencies and percentages, and the chi-square test was used for comparisons. Chi-square goodness-of-fit tests were performed to test the uniformity of patient distribution among the times of day and seasons. We performed a multivariate logistic regression analysis to find predictors associated with admission. All statistical tests were 2-sided, and a P

value of $< .05$ was considered statistically significant.

Ethics Statement

The study protocol was reviewed and approved by the Konkuk University Medical Center institutional review board (IRB No. KUH1260016). The requirement for informed consent from the participants was waived by the board.

RESULTS

During the study period, a total of 1,305,049 patients visited the 46 participating EDs. Of these patients, 23,653 (1.8%) patients with renal colic were included. The demographic and clinical features of the renal colic patients are summarized in **Table 1**. Renal colic episodes were significantly more common in men (66.6%) than in women (33.4%). The median patient age was 45 (35–54) years. The women were slightly but significantly older than the men (49 [37–58] vs. 43 [34–52] years, $P < .001$). The incidence of renal colic began to increase after the age of 20, peaked between the ages of 40 and the early 50s, and then began to decline (**Figure 1**). There were 11,750 (49.7%), 9,871 (41.7%), and 2,032 (8.6%) presentations of renal colic attacks in the 18–44, 45–64, and ≥ 65 -year age groups, respectively. The circadian pattern of renal colic attack is shown in **Figure 2**. A highly significant circadian pattern was observed in the overall population, with a morning peak (06:00–10:00 h) and afternoon dip (15:00–19:00 h). The onset of renal colic occurred between 06:00 and 12:00 h in 7,974 patients (33.7%), between 00:00 and 06:00 h in 5,844 patients (24.7%), between 18:00 and 24:00 h in 5,310 patients (22.4%), and between 12:00 and 18:00 h in 4,525 patients (19.1%). The incidence of renal colic was significantly higher between 06:00 and 12:00 h than during the other three 6-hour periods ($P < .001$). The peak incidence of renal colic occurred in the months of July, August, and September (6,916/23, 653, 29.2%); August had the highest incidence of renal colic (10.6% of all renal colic episodes). The number of ED visits according to a monthly analysis showed a significant increase during the hottest months of the year. The incidences of renal colic for each gender group and age group were higher in the summer ($P < .001$). The most common chief complaint was flank pain (61.1%), followed by abdominal pain (22.9%) and hematuria (1.6%). The mode of arrival was mainly private ground transport (47.8%), followed by walk-in (35.8%) and emergency medical service ambulance (13.1%) (**Table 1**). A total of 21,807 (92.2%) patients were managed and discharged from the EDs, and only 1,416 (6.0%) patients were admitted; 175 (0.7%) of the admitted patients were transferred to other hospitals. The median LOS of all patients was 171 (122–255) min. Factors associated with a short LOS in the EDs were male gender, time of visit from 18:00–24:00 h, and a Saturday visit ($P < .001$). In contrast, the LOS did not correlate significantly with age group (**Table 2**). The number and rate of admitted patients with renal colic are summarized in **Table 3**. Women (8.3%) had a higher admission rate than men (6.0%). The older age group (≥ 65 years) had the highest admission rate (11.6%). The admission rate of patients who visited on Monday (7.8%) was significantly higher than that of patients who visited on other days of week. However, the seasonal variation in the admission rate was not significant ($P = .894$).

Table 4 demonstrates the results of a multivariate logistic regression analysis to find predictors associated with hospital admission. Women were 1.3 times more likely to be admitted than men. The older age group had a significantly higher likelihood of admission, compared with the other age groups (odds ratio [OR] 2, 95% confidence interval [CI]: 1.70–2.33). The probability of admission in patients who visited EDs from 00:00–06:00 h was significantly lower than that of patients who visited during other times of the day. Visits on Monday had a 1.55-fold higher OR for admission (95% CI: 1.28–1.87) compared with visits on Sunday.

DISCUSSION

The present study revealed demographic, epidemiologic, and clinical data from patients with renal colic in EDs in Korea. Urolithiasis was more common in men than in women in our study, with a male-to-female ratio of 2:1, and the peak incidence of renal colic occurred in the fifth and early sixth decades of life. These results were consistent with the results of previous studies.^(10–12) In a prior study, circadian variations in renal colic were observed and characterized by a morning peak independent of gender or the presence of demonstrable kidney stones.⁽¹³⁾ Another study showed that the highest and lowest rates of hospital visits due to renal colic were recorded in the morning and during the night, respectively.⁽¹⁴⁾ In the present study, we also found that episodes of renal colic exhibited a significant circadian pattern with a morning peak and an afternoon dip. However, our results differed slightly from those of a previous study of the hourly distribution of visits to the ED. The peak morning time reported in a study by Cupisti and colleagues was between 09:00 and 12:00 h,⁽¹²⁾ whereas in our study we observed a morning peak from 06:00 to 10:00 h. The results of previous studies represented single-center data with relatively small sample sizes. Therefore, it was not possible to generalize those results to the general population. In contrast, this study was the first large population-based study to examine circadian variations in the incidence of renal colic attack. The results of our investigation confirm that episodes of renal colic exhibit a circadian pattern characterized by a morning peak. Urinary stone formation can be influenced by many factors such as stone-forming components, urinary pH, and inhibitors and promoters of crystallization. Most, if not all, renal functions (e.g., glomerular filtration, urine production, and renal solute excretion) exhibit temporal changes leading to an increasing nighttime urine concentration, which could act as a predisposing factor for the morning occurrence of renal colic attacks. In addition, the rates of urine production and renal solute excretion reach minimum levels during the night.⁽¹⁵⁾ As expected, our study showed that the greatest incidence of renal colic occurred during the summer, whereas the lowest incidence was observed during the winter. The seasonal variation in renal colic onset in Korea exhibited a peak in July, August, and September, following the warmest months of the year (June, July, and August). Furthermore, seasonal variations in renal colic did not differ significantly by patient gender or age. However, a study conducted in Iraq found a correlation between renal colic onset and the autumn months, and a Norwegian study associated a high incidence of renal colic with the autumn

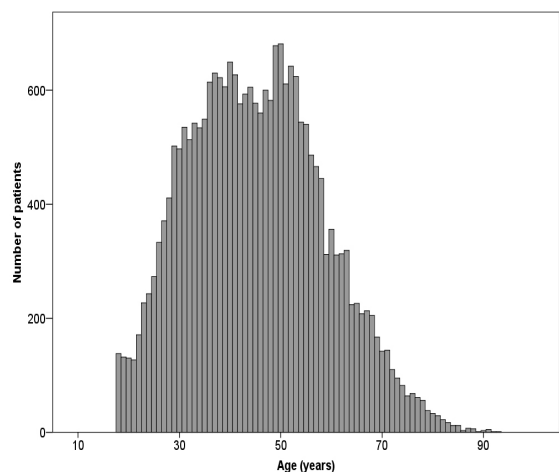


Figure 1. Age distribution of renal colic patients (n = 23,653).

and winter months.^(16,17) In other studies, a peak incidence of renal colic occurs during the summer, and the mean number of renal colic visits per day and the mean daily temperature shows a very high and significant correlation.^(18,19) In contrast, a study conducted in Sweden failed to observe any seasonal correlations.⁽²⁰⁾ The symptom of flank pain has been reported to be the most common chief complaint of patients with renal colic, followed by abdominal pain.⁽²¹⁾ Likewise, these complaints were the 2 most common symptoms in the present study (61.1% and 22.9%, respectively). The pain is often described as waxing and waning with a maximal intensity lasting 20–60 min. In our study, female patients had a longer LOS, compared with male patients. A longer LOS may reflect larger amounts of ED resources required for patient care. Elderly patients generally require more ED resources, and thus a longer LOS should be expected in the ED. Interestingly, increasing age did not correlate with a longer LOS in this study. The LOS of patients visiting from 18:00–24:00 h and on weekend days was shorter than that of patients visiting at any other time during the day and on weekdays. In contrast, Downing and colleagues observed that nighttime visits were associated with a higher risk of a longer LOS in

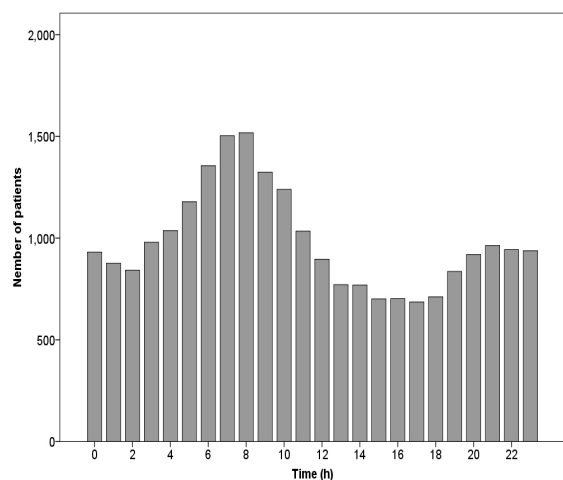


Figure 2. Circadian patterns of renal colic patients (n = 23,653).

Table 3. Number and rate of patients admitted with renal colic.

Variables	Admission Rate (%)	P Value
Gender		< .001
Male	938/15745 (6.0)	
Female	654/7908 (8.3)	
Age group (years)		< .001
18-44	672/11750 (5.7)	
45-64	684/9871 (6.9)	
≥ 65	236/2032 (11.6)	
Day of week		.001
Sunday	217/4034 (5.4)	
Monday	263/3376 (7.8)	
Tuesday	227/3368 (6.7)	
Wednesday	241/3240 (7.4)	
Thursday	211/3066 (6.9)	
Friday	221/3165 (7.0)	
Saturday	212/3404 (6.2)	
Season of year		.894
Spring	376/5637 (6.7)	
Summer	445/6766 (6.6)	
Autumn	412/5966 (6.9)	
Winter	359/5284 (6.8)	
Total	1592/23653 (6.7)	

the ED.⁽²²⁾ The longest LOS in the ED was observed on Mondays. Although a clear explanation for these finding is unknown, it would appear that Monday is the busiest day in hospital EDs and outpatient clinics. However, patients are more likely to require admission to the hospital on a Monday (admission rate 7.8%). The overall average rate of admission was 6%, a relatively low figure considering that in other studies, as many as 13–22% patients presenting with renal colic were admitted to the hospital.^(23,24) The admission rate increased with age in both male and female patients. Regarding older patients (≥ 65 years), the LOS in the ED did not differ from of the LOS of other age groups, but the admission rate was significantly higher (11.6%). However, seasonal variations did not have a significant effect on the admission rate. One potential reason for the low weekend admission rate is that it is more difficult to access additional supportive services at these times. This study had several limitations. First, the data were collected from relatively large metropolitan EDs, and therefore the generalization of our findings to EDs across the country may not be appropriate. Second, a one-year study period does not clearly account for seasonal variations and climatic influences. Additionally, the associations between events and climatic factors may be different in other geographical locations. The participating EDs lie between 35° and 37° latitude and experience 4 distinct seasons. Therefore, there seems to be little difference in climatic factors. A third limitation arises from the use of KCD-6 codes. These codes

Table 4. Multivariate logistic regression analysis of hospital admission.

Variables	Adjusted OR	95% CI
Gender		
Male	1	
Female	1.32	1.18-1.46
Age group (year)		
18-44	1	
45-64	1.18	1.06-1.32
≥ 65	2.00	1.70-2.33
Day of week		
Sunday	1	
Monday	1.55	1.28-1.87
Tuesday	1.34	1.11-1.63
Wednesday	1.49	1.23-1.81
Thursday	1.38	1.13-1.67
Friday	1.38	1.13-1.67
Saturday	1.19	0.98-1.45
Time of day (h)		
00:00-06:00	1	
06:00-12:00	1.33	1.15-1.54
12:00-18:00	1.81	1.55-2.11
18:00-24:00	1.30	1.10-1.52

Abbreviations: OR, odds ratio; CI, confidence intervals.

are assigned based on the ED diagnoses made by ED physicians. There may be some variability concerning how physicians identify patients with renal colic.

CONCLUSION

This large-scale study provides important epidemiologic and clinical information about patients with renal colic in a Korean population. The epidemiologic and clinical features derived from this study may facilitate further investigations aimed at understanding the etiology of renal colic.

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CONFLICT OF INTEREST

None declared.

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