Computed tomographic based determinaton with all aspect of spontaneous passage of ureteral stone

Eurasian Clinical and Analytical Medicine Original Research

Tomograpihc evaluaton of ureteral stone

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Abstract

Aim: The objective of this study is to determine tomographic measurement parametres that are effective on spontaneous passage (SP) of ureteral stones in patients who will undergo unenhanced multidetector computed tomographic examinations (MDCT).

Methods: The patients who presented with complaints of renal colic to our clinic during 2013-2015 were retrospectively evaluated. The medical files of 813 patients were reviewed and the medical records of 331 cases who had undergone CT were examined. A total of 217 patients whose stone size was less than 10 mm were included in the study. The patients whose stones passed were included in Group 1, and those whose stones did not pass spontaneously were included in Group 2. Data about age and gender of the patients, location, laterality, history of spontaneous stone passage from the ipsilateral side, ureteroscopy, shock wave lithotripsy (SWL), anteroposterior (AP) diameter of the renal pelvis, diameter of the stone as measured on coronal and axial planes, stone volume, and average thickness of the renal parenchyma were evaluated. Parametres effecting passage of the stone were statistically analysed.

Results: The mean age of the patients (female, n=152, and male, n=65) was 42.3 years. The patients had upper (n=73) and lower (n=144) ureteral stones. The median diameter of the renal pelvis (17.2 mm), stone diameter on the coronal plane (6.1 mm) and the axial plane (4.6 mm), and thickness of the renal parenchyma (20 mm) were measured. Statistical analysis revealed that the location, volume, diameter of the stone on the coronal and axial planes were influential factors on spontaneous stone passage. In logistic regression analysis, only the location of the stone and its diameter on the coronal plane were found to be independent effective factors on spontaneous stone passage.

Conclusion: In our study based on data retrieved from MDCT, the location and size of the stone were found to be independent factors affecting spontaneous stone passage. However, a surprising result is that the AP diameter of renal pelvis and renal parenchymal thickness, both of which are factors important for urologists, were not effective on SP.

Keywords

ureteral stone, unenhanced multidetector computed tomography, spontaneous passage

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Introduction

In our country, the incidence of urolithiasis is higher (14.8 %) than that of many other European countries.[1] Therefore, renal colic secondary to ureteral stone has an important place in daily urology practice. Currently, there are no clear-cut criteria for the management of renal colic secondary to ureteral stones. In cases with renal colic due to uncomplicated ureteral stones, the approach has been to observe and to hope for spontaneous passage of the stone(s). A small proportion of patients require interventional methods such as shock wave lithotripsy (SWL) and ureteroscopy. It is very difficult to predict which stones will spontaneously pass, or when.[2] Investigators performed many studies to clarify this gray zone of unpredictability, and predictive factors for spontaneous stone passage have been discovered. Most certainly, the most important of them is the size of the stone. Currently, although many imaging modalities are used, computed tomography (CT) has the highest diagnostic sensitivity.[3,4] In particular, multidedector CT (MDCT) provides coronal reconstruction which aids in the evaluation of all dimensions of stones.[5] So, we wanted to discover the factors that are effective on spontaneous stone passage by analysing the medical files of patients who had undergone MDCT.

Materials and Methods

We retrospectively reviewed the medical files of 813 patients who had presented to our clinic with a complaint of renal colic during 2013-2015. Of those, the hospital records of 331 patients who had undergone CT examinations were evaluated. In all patients, unenhanced CT examinations were performed using a 64-MDCT scanner (SOMATOM Sensation 64, Siemens Healthcare) and images obtained as 0.6 mm-thick axial sections were reconstructed. A total of 217 patients with stone diameter of 10 mm were included in the study. Patients with solitary kidneys, patients younger than 18 years of age, patients with incomplete follow-up tracking, and those with serious urinary infections or acute/chronic renal failure were not included in the study. After establishment of diagnosis, all patients were given medical expulsive treatment (MET) consisting of 2 liters of daily hydration, analgesics (diclofenac max. 150 mg/d),and tamsulosin (0.4 mg/d).[6] The patients were evaluated at 2 and 4 weeks with radiological methods (ultrasound and/or Kidney-Urether-Bladder (KUB)), and asked about spontaneous stone passage. The patients were divided into two groups—those who spontaneously passed their stones (Group 1) and those who did not (Group 2). Data about age and gender of the patients, location and laterality of the stone, anteroposterior (AP) diameter of the renal pelvis , diameters of the stones on the coronal and axial planes, stone volume, mean thickness of renal parenchyma, previously experienced spontaneous stone passage from the ipsilateral kidney, ureteroscopy, and SWL were evaluated. Ureteral stones above and below the crossing of the ureter over iliac vessels were evaluated as upper and lower ureteral stones. The AP diameter was measured on the axial plane where the renal pelvis has its longest horizontal diameter. The parenchymal thickness of upper, middle, and lower poles on the coronal plane was measured and the average of these three measurements was recorded as the average thickness of renal parenchyma. Stone volume was calculated based on the formula: V= (X) x (Y) x (Z) x 0.52. Parametres effective on spontaneous stone passage were statistically evaluated.

Statistical Analysis

Data were analysed using the IBM SPSS version 22 program. For univariate analysis, independent sample (t) test and chi-square test were used. Significant variables in univariate analysis were evaluated using binary logistic regression test. The Pearson test was employed for correlation analysis. Two-tailed p values <0.05 were considered statistically significant. Receiver operating characteristic (ROC) curve was used to determine the cut-off value for spontaneously passed stones. Area under curve (AUC) and asymptotic were evaluated as 95% CI.

Results

The study population consisted of 217 (female, n=152, and male, n= 65) patients with a mean age of 42.3±14.4 years. A subset of patients spontaneously passed stone(s) from the ipsilateral kidney (n= 33; 15.2%) or had undergone endoscopic ureteral stone (n=16; 7.4 %) or ESWL (n=2; 0.2 %) treatment for stone(s) in the ipsilateral kidney. The patients had upper (n=73; 33.6%) and lower (n=144; 66.4%) ureteral stones. The mean AP diameter of the renal pelvis AP was 17.2±5.9 mm. Mean diameters of the stones on the coronal and axial planes were 6.1±2.0 mm and 4.6±1.4 mm, respectively, while mean renal parenchymal thickness was 20±2.9 mm (Table 1). Univariate analysis performed both in Group 1 and 2 patients reveals similarities between the groups for age, gender, laterality of the

Table 1. The demographic data of patients.

	Total	Group 1	Group 2	p value
Age (mean ± SD)	42,3±14,4	42,2±14,3	42,4±14,6	0,866
Sex (n,%)				0,289
Female	152 (70)	92 (71,9)	60 (67,4)	
Male	65 (30)	36 (28,1)	29 (32,6)	
Laterality (n,%)				0,497
Right	106 (48,8)	62 (48,4)	44 (49,4)	
Left	111 (51,2)	66 (51,6)	45 (50,6)	
Previous spontaneous passage (n,%)				0,348
Yes	33 (15,2)	21 (16,4)	12 (13,5)	
No	184 (84,8)	107 (83,6)	77 (86,5)	
Previous ureteroscopy (n,%)				0,307
Yes	16 (7,4)	8 (6,2)	8 (9)	
No	201 (93,6)	120 (93,8)	81 (91)	
Previous SWL (n,%)				0,653
Yes	2 (0,2)	1 (0,8)	1 (1,1)	
No	215 (99,1)	127 (99,2)	88 (98,9)	
Localization (n,%)				0.000
Upper	73 (33,6)	24 (18,8)	49 (55,1)	
Lower	144 (66,4)	104 (81,2)	40 (44,9)	

Table 2. Computed tomographic data of the patients.

	Total	Group 1	Group 2	p value
Renal pelvic AP diameter (mm)	17,2±5,9	16,5±5,2	18,3 ±6,8	0,066
Coronal stone diameter (mm)	6,1±2,0	5,3±1,8	7,2±1,7	0.000
Axial stone diameter (mm)	4,6±1,4	4,1±1,2	5,3±1,4	0.000
Renal parenchymal tickness (mm)	20±2,9	21±2,5	20±3,4	0,312
Stone volume (mm^3)	70,7±68,5	48,1±47,0	103,1±80,8	0.000

Table 3. Multivariate analyses for factors that may affect spontaneous passage

	Total	Group 1	Group 2	p value
Renal pelvic AP diameter (mm)	17,2±5,9	16,5±5,2	18,3 ±6,8	0,066
Coronal stone diameter (mm)	6,1±2,0	5,3±1,8	7,2±1,7	0.000
Axial stone diameter (mm)	4,6±1,4	4,1±1,2	5,3±1,4	0.000
Renal parenchymal tickness (mm)	20±2,9	21±2,5	20±3,4	0,312
Stone volume (mm^3)	70,7±68,5	48,1±47,0	103,1±80,8	0.000

stone, previously experienced spontaneous stone passage, ureteroscopy, and ESWL (p>0.05). Similarly, renal pelvis AP diameter and mean thickness of renal parenchyma did not differ between groups (p>0.05). In contrast, location of the stone (p=0.000), diameters of the stones as measured on the coronal (p=0.000) and axial (p=0.000) planes, and stone volume (p=0.000) were found to be effective factors on stone passage (Table 2). In logistic regression analysis, only location (p=0.001, OR=3.3) and coronal diameter (p=0.003, OR=0.6) of the stone were independent factors effective on spontaneous stone passage (Table 3).

Discussion

To date, researchers have reviewed demographic, radiological, and biochemical parametres and investigated the factors effecting spontaneous stone passage.[5,7-10] In the detection of the presence and size of the stone, one of the imaging modalities such as KUB, US, IVP or CT can be used.[11,12] Among these, CT is certainly the most sensitive imaging modality.[3,4,13] Stone size is the most important factor effecting spontaneous stone passage. In a prospective study peformed by Miller et al. on spontaneous passage of ureteral stones, the researchers investigated predictive factors effective on the time of spontaneous stone passage and related predictive factors. In conclusion, stone size less than 6 mm, and location of the stone in the distal ureter and on the right side were detected as predictive factors. In their study, the great majortity of the stones passed spontaneously within 40 days. According to the same study the incidence of interventions increases proportionally with stone size.[14] Measurement of stone size based on axial plane sections of the stone, a method practised previously, underestimates stone size. Due to developing technology, coronal reconstruction performed using MDCT has enabled more precise crano-caudal measurement of the stone size. In a study performed by Demehri et al. on ureteral stones with diameters ranging between 5 and 10 mm, the authors emphasized that, in addition to stone size, the surface area of the stone measured on the axial plane is a more accurate predictive factor for SP.[8] However, Zorba et al. estimated the approximate volume of the stone (SV), and demonstrated that in addition to other parametres, SV together with the longest diameter (LD) of the stone as measured on the coronal CT sections were independent factors effecting spontaneous stone passage. Cut-off values for SV and LD were found to be 52.6 mm3 and 7 mm, respectively. Based on this study the volume of the spontaneously passed stones with a diameter of > 7 mm was statistically significantly less than the volume of those retained. The volume of the spontaneously passed stones with a diameter of < 7 mm was not different from the volume of those retained in the ureter.[9] However, in our study, based on univariate analysis, a significant correlation was detected between SV and SP (p=0.000), while in univariate analysis SV was not found to be an independent predictive factor (p=0.635).In studies performed by Özcan et al. and Sfoungaristos et al. the role of inflammatory markers on spontaneous stone passage was investigated. To summarize, the authors determined that C-reactive protein (CRP) and white blood cell (WBC) values were correlated with SP. They also stated that when deciding on MET for SP these parametres should be taken into consideration.[15,16] Tchey et al. investigated the impact of BMI and the history of SP in addition to the parametres of SP time and stone size suitable for SP. According to univariate analysis, both parametres were ineffective on spontaneous stone passage.[17] However, in our study, as in previous studies, no correlation was found between spontaneous stone passage and previous SWL and ureteroscopy. Looking at the outcomes of a small number of studies on the impact of hydronephrosis on SP, no consensus has emerged. Based on the results of univariate and multivariate analysis performed by Özcan et al., the presence of hydronephrosis was reported as a predictive factor for SP. In a univariate analysis conducted by Zorba et al. a significant correlation was detected between SP and the presence of hydronephrosis.[9,15] However, in multivariate analysis the presence of hydronephrosis did not appear to be an independent predictive factor. Both of these studies evaluated only the grade of hydronephrosis. However, to the best of our knowledge, our study is the first in which axial CT sections anteroposterior (AP) diameters of the renal pelvis were measured and relevant data were used. As a result, a significant correlation between increase in AP diameter and SP could not be demonstrated (p=0.066). When factors effective on hydronephrosis were investigated, a correlation between the patient's age and diameter of the renal pelvis was

detected in our study. In other words, the AP diameter of the renal pelvis increases with aging (r=0.278, p=0.000). According to our theory, tissue strength may decrease with increasing age, resulting in further increases in AP diameters of the renal pelvis as a response to acute obstruction.As far as we know, our study is also the first time the effect of the mean thickness of renal parenchyma on spontaneous stone passage has been investigated. According to data retrieved from axial CT sections, the effect of average renal parenchymal thickness on spontaneous stone passage has not been demonstrated (p=0.312). Consistent with the literature, the location of the stone was found to be effective on spontaneous stone passage.[18] Based on ROC analysis, the cut-off value for coronal stone size was established as 6 mm (AUC= 0.767, sensitivity 78.7% , and specificity 62.5%).Our study has some limitations. Primarily, these are the retrospective design of the study and the lack of data about the time of spontaneous stone passage, demographic characteristics of the patients (body weights and heights of the patients, comorbidities), and inflammation markers such as CRP. Even so, we think that the data we acquired solely from CT measurements will contribute to reducing the gray zone of unpredictability concerning spontaneous stone passage.

Conclusion

In our study, based on MDCT data, the location and size of the stone were found to be independent factors effecting spontaneous stone passage. Patients with distal ureteral stones with a diameter of 6 mm appear to have a greater chance of spontaneous stone passage. The mean renal parenchymal thickness and the AP diameter of the renal pelvis, which we have been the first to evaluate, were not found to be related to spontaneous stone passage.

Declarations

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments.

Informed Consent

Informed consent was obtained from all participants.

Conflict of Interest

The authors declare no conflicts of interest.

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Scientific Responsibility Statement

The authors declare that they are responsible for the scientific content of the article, including the study design, data collection, analysis and interpretation, manuscript preparation, and approval of the final version of the manuscript.

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