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Original Article / Araştırma Makalesi

THE RELATIONSHIP BETWEEN THE SIZE AND LOCALIZATION OF THE URETERAL STONE AND THE DEGREE OF HYDRONEPHROSIS

Üreter Taşının Boyut ve Lokalizasyonu ile Hidronefroz Derecesi Arasındaki İlişki

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ABSTRACT

The aim of our research is to evaluate whether there is a relationship between the degree of hydronephrosis and, the size and location of the stones in the ureter in patients with ureteral stones, with computed tomography (CT). 105 patients who applied to Malatya Training and Research Hospital with the complaint of renal colic and underwent CT scan were included in the study. Hydronephrosis was evaluated by using the system developed by the Society of Fetal Urology. Stone sizes were grouped as <5 mm, 5 – 10 mm, and ≥ 10 mm. The location of the stones were indicated as proximal - middle - distal according to the anatomical parts of the ureters. 61 (58.1%) patients had stones in the distal ureter, 20 (19%) had stones in the middle ureter, and 24 (22.9%) had stones in the proximal ureter. It was determined that the stone size showed significant difference according to the degree of hydronephrosis ($p<0.05$). There was no significant relationship between the stone location being in the proximal, middle or distal parts of the ureter and the degree of hydronephrosis ($p=0.241$). While, as the size of ureteral stones increases the degree of hydronephrosis increases, there is no relation with the location of the stone and hydronephrosis.

Keywords: Calculi, Hydronephrosis, Ureter.

ÖZ

Çalışmamızın amacı üreter taşı olan hastalarda hidronefroz derecesi ile üreterdeki taşların boyutu ve yerleşimi arasında bir ilişki olup olmadığını bigisayarlı tomografi (BT) ile değerlendirerek araştırmaktır. Malatya Eğitim ve Araştırma Hastanesi'ne renal kolik şikayeti ile başvuran ve BT taraması yapılan 105 hasta bu çalışmaya dahil edildi. Hidronefroz, Fetal Üroloji Derneği tarafından geliştirilen derecelendirme sistemi kullanılarak değerlendirildi. Taş boyutları ise <5 mm, 5 – 10 mm ve ≥ 10 mm olarak belirlendi ve gruplara ayrıldı. Üreterlerin anatomik kısımlarına göre taşların yerleşimi proksimal - orta - distal olarak belirtildi. 61 (%58.1) hastada üreter distal kesiminde, 20 (%19) hastada orta üreter kesiminde, 24 (%22.9) hastada üreter proksimal kesiminde taş vardı. Taş boyutunun hidronefroz derecesine göre istatistiksel olarak anlamlı farklılık gösterdiği belirlendi ($p<0.05$). Proksimal, orta veya distal üreter segmentinde taş varlığı ile hidronefroz derecesi arasında istatistiksel olarak anlamlı bir ilişki yoktu ($p=0.241$). Üreter taşlarının boyutu arttıkça hidronefroz derecesi artarken, taşın üreterdeki yerleşiminin hidronefroz ile ilişkisi yoktur.

Anahtar kelimeler: Hidronefroz, Kalkül, Üreter.

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INTRODUCTION

'Urinary tract stones' is one of the problems affecting approximately 15% of the world's population (Aune, Mahamat-Saleh, Norat & Riboli, 2018). Approximately 60% of ureteral stones can be expelled spontaneously. Various factors as the composition, size, location of the stones, and metabolic diseases affect stone excretion (Bihl & Meyers, 2001).

In recent studies, it has been shown that 68% - 98% of distal ureteral stones smaller than 5 mm in size and 47% of stones between 5-10 mm in size can spontaneously passed (Daga et al., 2016; Preminger et al., 2007; Smith, Shah & Patel, 2009). Those larger than 10 mm are less likely to pass spontaneously and need urological intervention (Preminger et al., 2007) The recommendation in current guidelines is surgical removal in most cases for stones larger than 10 mm (Preminger et al., 2007).

Stone size, stone location, history of spontaneous excretion in the past, diabetes and C-reactive protein (CRP) can be counted among the factors affecting spontaneous excretion (Ahmed et al., 2015; Mohammad, Abbas, Hassan & Abdulrazaq, 2018).

Non-contrast computed tomography (CT) has now become the predominant imaging modality as it allows to assess stone size, location, degree of hydronephrosis and other pathophysiological processes (Brown, 2006; Katz et al., 2000; Teichman, 2004). CT scans also provide a variety of information about ureteral stones, including stone diameter, degree of ureteral enlargement, and location of ureteral stones (Lee, Jeon, Park & Choi, 2012).

The aim of our study is; to evaluate the degree of hydronephrosis and the size and localization of stones in the ureter on CT in patients with ureteral stones, to investigate whether there is a relationship between them and to question whether ureteral stone presence is a risk factor for possible permanent kidney damage due to hydronephrosis.

MATERIAL AND METHOD

Ethical Declaration

For this study, permission was obtained from the Malatya Turgut Özal University, Non-Interventional Clinical Research Ethics Committee (Approval no: 2022/123), and the Helsinki Declaration criteria were taken into consideration.

According to the power analysis calculation by using the G*power 3.1 program; The sample size was determined as 105 with an effect size of 0.41, a margin of error of 0.05, a confidence level of 0.95, and a population representation of 0.95.

Patients who applied to Malatya Training and Research Hospital with the complaint of renal colic between June 1, 2020 and December 31, 2021 and had CT scan were included in the study. Inclusion criteria in our study were: presence of ureteral stones and being older than 18 years. Those with CT image artifacts and only renal or bladder stones were excluded from the study.

Non-contrast CT scans were performed by using the Philips Medical System MX-128-slice multidetector (Koninklijke Philips N.V., Eindhoven, Netherlands) device at 120 kV, 250 mA and 5 mm slice thickness protocol and, were transferred to the picture archiving and communication system (PACS). The size of the stone, the localization of the stone, and the degree of hydronephrosis were determined for each patient, as well as demographic data such as age and gender.

Hydronephrosis grading system developed by the Fetal Urology Society (SFU) was used. According to the grading system; no dilatation (Grade 0), dilatation of the renal pelvis with or without dilatation of the calyces (Mild hydronephrosis: grades 1 and 2), moderate enlargement of the renal pelvis and calyces (Moderate hydronephrosis: grade 3), prominent dilatation of the renal pelvis and calyces accompanied by cortical thinning (Severe hydronephrosis: grade 4) was investigated (Fernbach et al., 1993) (Figure 1).

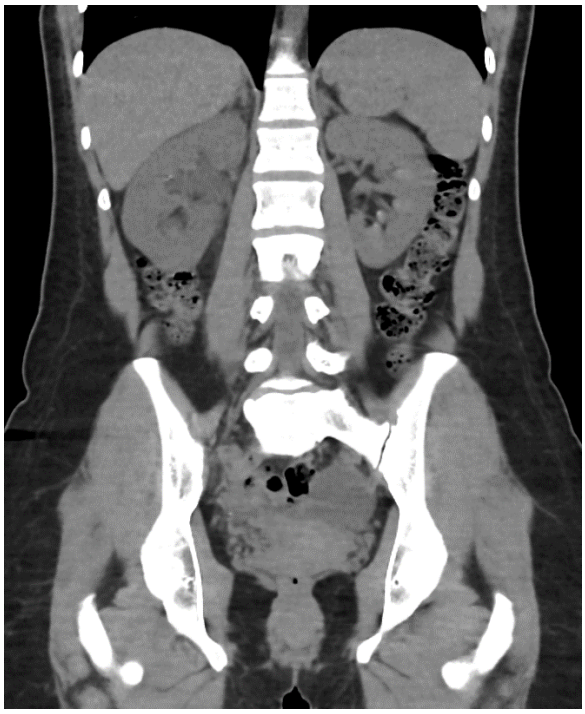

Figure 1. Coronal CT Image of a Patient with Moderate Hydronephrosis of the Right Kidney According to the Fetal Urology Society Classification.

Stone sizes were divided into groups of <5 mm, 5–10 mm, and ≥10 mm and above, based on the estimation of ease of passage (Preminger et al., 2007).

The localization of the stones was specified as proximal - middle - distal according to the anatomical parts of the ureters (Pereira et al., 2010). Accordingly, those extending from the ureteropelvic junction to the area where the ureter passes the sacroiliac joint were considered to be proximal, the parts up to the bone pelvis were considered to be in the middle, the parts extending to the bladder at the level of the iliac vessels were considered to be distal.

Statistical Analysis

The analysis of the data included in the research was carried out with the SPSS (Statistical Program in Social Sciences) 25 program. The Kolmogorov Smirnow Test was used to check whether the data included in the study fit the normal distribution. The significance level (p) for comparison tests was taken as 0.05.

Since the variables did not have a normal distribution (p>0.05), the analysis was continued with non-parametric test methods.

The Kruskal Wallis test analysis was performed for comparisons in multiple independent groups. Since the p value would increase depending on the increase in the number of comparisons in the variables with a difference, the Bonferroni corrected p value was used and calculated with “0.05/binary comparison”. After the Kruskal-Wallis test, the p values obtained by the Mann-Whitney test were compared with the calculated p values and the result was decided.

RESULTS

The mean age of the patients included in the study was 43.50 ± 12.968, the mean age of women was 43.13 ± 13.305, and the mean age of men was 43.61 ± 12.953. Of the 105 patients, 82 (78.1%) were male and 23 (21.9%) were female.

Of 105 patients, 47 had stones in the right ureter and 53 had stones in the left ureter. 61 (58.1%) patients had stones in the distal ureter, 20 (19%) patients had stones in the middle ureter, and 24 (22.9%) patients had stones in the proximal ureter.

Hydronephrosis was mild in 26 patients, moderate in 62 patients, and severe in 15 patients. There were only 2 patients with grade 0 hydronephrosis and grade 0 was not included in the statistical analyses, as this number was not sufficient for statistical analysis.

It was determined that the size of the stone showed a statistically significant difference according to the degree of hydronephrosis (p<0.05). In addition, a significant correlation was

found between the stone size group and the hydronephrosis group according to spontaneous excretion ($p<0.001$). While 20 (74.1%) of the patients with stone size over 10 mm had grade 2 hydronephrosis, 7 (25.9%) had grade 3 hydronephrosis, while only 1 (16.7%) of the patients with stones smaller than 5 mm had grade 2 hydronephrosis. Grade 3 hydronephrosis was not observed in any of the patients with stones less than 5 mm (Table 1). The mean stone size was found to be 11.1 ± 6.6 in patients with grade 3 hydronephrosis (Table 2).

Table 1. Relationship Between Stone Size Group and Hydronephrosis Group

			Hydronephrosis grade			Total
			1	2	3	
Stone Size	0-5 mm	n	5	1	0	6
		%	83.3%	16.7%	0.0%	100.0%
	5-10 mm	n	21	41	8	70
		%	30.0%	58.6%	11.4%	100.0%
	>10 mm	n	0	20	7	27
		%	0.0%	74.1%	25.9%	100.0%
Total		n	26	62	15	103
		%	25.2%	60.2%	14.6%	100.0%

n: Number of patients

Table 2. Relationship Between Mean Stone Size and Grade of Hydronephrosis

Hydronephrosis grade	Stone size average ± SD	p
1 (n=26)	6.0 ± 1.5	<0.001
2 (n=62)	8.4 ± 2.8	
3 (n=15)	11.1 ± 6.6	
Total (n=103)	8.2 ± 3.7	

n: Number of patients

DISCUSSION

Although hydronephrosis is widely used by clinicians for guidance in decision making, different determinations have been made about its relationship with the inability to spontaneously pass of the stone and its relationship with the size of the stone (Daniels et al., 2016, 2017; Leo et al., 2017).

Studies addressing hydronephrosis and stone size have generally been conducted with small number of patients. Similar studies have found that hydronephrosis is weakly associated with stone size, but a small number of patients with stones ≥ 5 mm have been studied (Goertz & Lotterman, 2010; Moak, Lyons & Lindsell, 2012).

Riddell found that hydronephrosis presence was 90% sensitive for stones > 6 mm, but did not express specificity or differentiate hydronephrosis categories (Riddell et al., 2014). Another study found large stones in 17% of patients with various forms of hydronephrosis and 28% of

patients with "moderate-to-severe" hydronephrosis (Daniels et al., 2016). We found the mean stone size to be 11.1 mm, with the highest stones to be in patients with stage 3 hydronephrosis.

In a study with ultrasound imaging it was determined that the degree of hydronephrosis increased with the increase in the proportion of ureteral stones larger than 5 mm (Goertz & Lotterman, 2010) In our study, a significant difference was found between the stone size and the increasing degree of hydronephrosis.

Non-contrast CT is a frequently preferred imaging modality in patients with acute flank pain or suspected ureteral stones (Lee et al., 2012). CT is requested in almost 83% of patients, especially during an acute attack (Schoenfeld et al., 2017). In our current study, we evaluated the ureteral stone size and localization and the degree of hydronephrosis on CT images.

Although a study using CT images predicted a high risk of excretion failure in severe hydronephrosis, non-existent and mild hydronephrosis was found to have a favorable prognosis (Innes, Scheuermeyer, McRae, Teichman, et al., 2021). According to the same study, moderate hydronephrosis is weakly associated with larger stones, but not with significantly larger passage failure (Innes, Scheuermeyer, McRae, Teichman, et al., 2021). In another study, those without hydronephrosis had a higher chance of successful excretion (Ahmed et al., 2015).

The results of some recent studies have shown that the size and location of the stone play a very important role in spontaneous excretion (Jendeberg, Geijer, Alshamari, Cierzniak & Lidén, 2017; Sfoungaristos, Kavouras, Kanatas, Duvdevani & Perimenis, 2014). Usually stones smaller than 5 mm will fall out on their own. However, early intervention or medical treatment may be required for large stones (Hollingsworth et al., 2016; Innes, Scheuermeyer, McRae, Law, et al., 2021). Studies in the literature generally show that 70% of distal ureteral stones are spontaneously excreted (Dellabella, Milanese & Muzzonigro, 2005; Johnson, Wilson, O'Fallon, Malek & Kurland, 1979; Stamatelou, Francis, Jones, Nyberg Jr & Curhan, 2003). It is also stated that a history of spontaneous excretion in the past, diabetes and CRP may also be effective factors (Mohammad et al., 2018).

In the literature, there is no study indicating whether there is a relationship between hydronephrosis and the ureter localization of the stone which is one of the factors affecting the spontaneous excretion of the stone. In our current study, we also investigated the relationship between stone localization and hydronephrosis. According to our results, we determined that the presence of the stone in the proximal, middle or distal ureter did not affect hydronephrosis. From this point of view, we can conclude that hydronephrosis is not among the factors facilitating the spontaneous excretion of the distal ureteral stone.

However, as it is known, the duration and severity of stone-related obstruction determine the degree of renal function loss. If the blockage is not removed, it can lead to permanent kidney damage. Hydronephrosis is considered acute if kidney function fully recovers when a blockage is cleared, whereas in chronic hydronephrosis, kidney function does not improve even after the obstruction is cleared (Thotakura & Anjum, 2022). Accordingly, we can say that the presence of the stone in the proximal, middle or distal ureter does not affect hydronephrosis, which may cause kidney damage.

The retrospective nature of our study and the small number of patients can be shown as the limiting factors of our study. In addition, we do not have any information about spontaneous stone excretion in the patients we included in our study.

CONCLUSION

As a result, as the size of ureteral stones increases, the degree of hydronephrosis also increases, while the localization of the stone in the ureter has no relation with hydronephrosis. While these two factors are taken into consideration in the spontaneous excretion of the stone, stone size is also important in the evaluation of hydronephrosis.

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