

## Ortalama ve Maksimum Üreter Duvar Kalınlığı Üreteroskopi Sonuçları için Öngörücü Faktör müdür?

### Average, and Maximum Ureteral Wall Thickness are Predictor Factor for Ureteroscopy Outcomes?

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#### ÖZ

**Amaç:** Çalışmamızın amacı operasyon öncesi bilgisayarlı tomografi ile ölçülen ortalama ve maksimum üreter duvar kalınlıklarının üreteroskopi sonuçları üzerindeki etkisini araştırmaktır.

**Materyal ve Metot:** Bu prospektif çalışma Temmuz-Aralık 2021 tarihleri arasında üreter taşı nedeniyle üreteroskopi yapılan 103 hasta ile yapılmıştır. Kontrastsız bilgisayarlı tomografi ile üreter taşının olduğu bölgedeki maksimum üreter duvar kalınlığı ve 3-6-9-12 hizalarından ölçülen üreter duvar kalınlıkları ortalaması alındı. Ortalama üreter duvar kalınlığı ve maksimum duvar kalınlığına göre operasyon süresi, rezidü taş ve double j takılma durumu ve intraoperatif komplikasyon durumu incelendi.

**Bulgular:** Çalışmaya dahil edilen 103 hastanın 77'si erkek, 26'sı kadındı. Hastaların yaş ortalaması 43,83±15,11 yıl idi. Ortalama taş uzunluğu 10,76±3,84 mm idi. Maksimum üreter duvar kalınlığı 4,9±1,8 mm iken ortalama üreter duvar kalınlığı 3,81±1,24 mm idi. Maksimum ve ortalama üreter duvar kalınlığı arttıkça operasyon süresi, rezidü taş ve double j takılma oranı, post üreteroskopik lezyon skala derecesinin arttığı görüldü (p<0,05).

**Sonuç:** Maksimum ve ortalama üreter duvar kalınlıkları üreteroskopi sonuçlarını öngörmeye prediktif faktörlerdir.

**Anahtar Kelimeler:** Tomografi, üreter duvar kalınlığı, üreter taşı, üreteroskopi

#### ABSTRACT

**Objective:** The aim of our study is to investigate the effect of average and maximum ureteral wall thicknesses measured by computed tomography before the operation on ureteroscopy results.

**Materials and Methods:** This prospective study was conducted with 103 patients who underwent ureteroscopy for ureteral stones between July and December 2021. The maximum ureteral wall thickness in the region of the ureteral stone and the average of the ureteral wall thicknesses measured from the 3-6-9-12 lines were calculated by non-contrast computed tomography. The operation time, residual stone, double j insertion status, and intraoperative complication status were examined according to the average ureteral wall thickness and maximum wall thickness.

**Results:** Of the 103 patients included in the study, 77 were male, and 26 were female. The mean age of the patients was 43.83±15.11 years. The mean stone length was 10.76±3.84 mm. The average ureteral wall thickness was 3.81±1.24 mm, while the maximum ureteral wall thickness was 4.9±1.8 mm. It was found that as the maximum, and average ureteral wall thickness increased, the operation time, residual stone, double insertion rate, and post-ureteroscopy lesion scale grade increased (p<0.05).

**Conclusion:** Maximum and average ureteral wall thicknesses are predictive factors for ureteroscopy results.

**Keywords:** Tomography, ureteral calculi, ureteral wall thickness, ureteroscopy

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## INTRODUCTION

Ureteral stones are one of the most common urological diseases. Its incidence and prevalence are increasing. Although most of these stones are eliminated by spontaneous passage, some require intervention. Many methods such as medical expulsive therapy, extracorporeal shock wave therapy (ESWL), open ureterolithotomy, laparoscopic ureterolithotomy, and ureteroscopy are used for the treatment of ureteral stones. However, the most frequently preferred method is ureteroscopy (URS), a minimally invasive surgery.<sup>1</sup>

Although URS is minimally invasive, it is not without complications, and success is uncertain. Many factors affect the success of URS and the development of complications. One of them is the impact of the stone. During the ureteral passage, because of the stone staying in a region of the ureter for a long time, edema, and hypertrophy occur in the ureteral wall through local mediators. The thickened ureteral wall compresses the stone and causes the stone to be impacted. This causes difficulty accessing the stone during URS, more postoperative (post-op) residual stones, more mucosal damage, and bleeding. Therefore, new techniques are needed to understand preoperative (pre-op) impacted stone formation.<sup>2-4</sup>

Studies have been reported to predict the success of ESWL and spontaneous stone passage by measuring the wall thickness of the ureter where the stone is shown by computed tomography.<sup>5,6</sup> In this study, we aimed to study the effect of the maximum wall thickness in the stone region, and the average wall thickness on the success of URS.

## MATERIALS AND METHODS

**Patients and Ethical Status:** This prospective study was conducted between July and December 2021 after obtaining local ethics committee approval by Van Yuzuncu Yil University Interventional Clinical Research ethics committee (Date: 29.04.2021, decision no: 10). The study was performed following the Helsinki criteria. Written informed consent was obtained from all participating patients. The inclusion criteria of the patients were being older than 18 years of age and having ureteral stones between 7 and 20 mm, while the exclusion criteria were being younger than 18 years of age, having solid kidneys, having more than one ureteral stone, having acute azotemia, being pregnant, with a Double J stent (DJ) or having a nephrostomy, a

history of ESWL or URS, and any ureteral pathology. Of the 124 adult patients examined, 21 were excluded because of acute azotemia, having DJ or nephrostomy catheter, and having a history of ESWL or URS. The study was conducted with a total of 103 patients who met the inclusion criteria. All patients were operated on after pre-op negative urine culture was documented.

**Computed Tomography (CT) Technique:** Non-contrast CT examination of the urinary tract (stone protocol) has been performed in all patients in our center. The routine CT scan protocols were as follows; CT scans were acquired using the multislice CT device with 16 detectors (Somatom Emotion 16-slice; CT 2012 Siemens AG Berlin, and Munchen-Germany). The patients lay on the CT table in the supine position with their arms raised behind their heads. Initially, a topogram in anteroposterior view was extended from the lower chest to the upper thighs. Then, scans were performed using a slice thickness of 3 mm from the liver dome to the underside of the ischial tuberosity, and images were reconstructed with a slice thickness of 1.5 mm.

**Imaging Analysis:** A radiologist with eight years experienced in abdominal radiology made CT evaluations without prior knowledge of patient's data. Stone side, stone location, hydronephrosis (HN) levels were recorded in pre-op non-contrast CT of all patients.

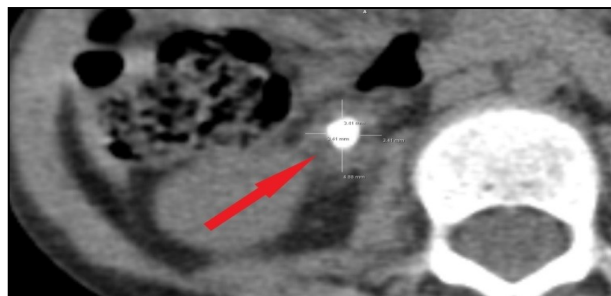
**Surgical Procedure:** All patients were operated on with the same semirigid ureterorenoscope (distal 8 fr proximal 9.8 fr diameter, Wolf brand German ureterorenoscope) after pre-op 2gr prophylactic ceftriaxone intravenous administration. Lithotripsy was performed with Wolf brand holmium laser with a frequency of 2000, and 1200 joules. Complications during the procedure were evaluated with the post-ureteroscopic lesion scale (PULS).<sup>7</sup> Postureteroscopic lesion scale: Grade 0=No Lesion; Grade 1=Superficial mucosal lesion, and/or significant mucosal edema/hematoma; Grade 2=Sunmucosal lesion; Grade 3=Perforation with less than 50% (partial) transection; Grade 4= More than 50% but less than 100% (partial) transection; Grade 5=Complete transection. To avoid bias, the people who performed the operation and recorded the PULS score were not informed about the pre-op CT measurements. Post-op, residual stone control of all patients was evaluated with kidney-ureter-bladder (KUB) radiography. Patients with <2 mm stones in intra-op and post-op KUB evaluation were

considered stone-free.

**Statistical Analysis:** Continuous variables are expressed as mean, and Standard Deviation, while categorical variables are expressed as numbers and percentages. One-way analysis of variance was performed to compare group means in terms of continuous variables. Pearson correlation coefficients were calculated to determine the relationship between these variables. The statistical significance level was taken as 5% ( $p < 0.05$ ) in the calculations, and the SPSS statistical package program was used for the analyses.

**RESULTS**

Of the 103 patients included in the study, 77 (74.7%) were male, and 26 (25.2%) were female. The mean age of these patients was  $43.83 \pm 15.11$  (18-82) years. The mean stone size was  $10.76 \pm 3.84$  mm. The stone was on the left in 59 (57.2%) patients on the right in 44 (42.7%) patients. While the stone was in the proximal ureter in 31 (30%) patients, it was in the middle ureter in 29 (28.1%) patients and the distal ureter in 43 (41.7%) patients. The largest diameter of the stone, the thickest ureteral wall



**Figure 1.** Ureteral wall thickness measurement on 3-6-9-12 lines in non-contrast computed tomography.

**Table 1.** PULS level, DJ, and residual stone rate, hydronephrosis degree according to maximum ureteral wall thickness.

		Maximum Ureteral Wall Thickness	p Value
PULS	0	<sup>c</sup> 2.66 ± 0.26	0.001
	1	<sup>c</sup> 3.26 ± 0.37	
	2	<sup>b</sup> 5.22 ± 1.50	
	3	<sup>a</sup> 8.52 ± 1.42	
DJ	Yes	5.08 ± 1.91	0.004
	No	3.38 ± 0.69	
Residue Stone	Yes	6.94 ± 1.86	0.001
	No	4.05 ± 1.10	
Hydronephrosis	1	<sup>d</sup> 3.09 ± 0.49	0.001
	2	<sup>c</sup> 4.76 ± 1.41	
	3	<sup>b</sup> 7.02 ± 1.03	
	4	<sup>a</sup> 9.33 ± 2.52	

DJ: Double J; PULS: Post Ureterscopic Lesion Scale; <sup>a, b, c, d</sup>. There is a significant difference between groups with different letters.

**Table 2.** PULS level, DJ, and residual stone rate, hydronephrosis degree according to average ureteral wall thickness.

		Average ureteral wall thickness	p Value
PULS	0	<sup>c</sup> 2.30 ± 0.303	0.001
	1	<sup>c</sup> 2.76 ± 0.372	
	2	<sup>b</sup> 4.08 ± 1.08	
	3	<sup>a</sup> 5.63 ± 1.034	
DJ	Yes	3.94 ± 1.23	0.001
	No	2.69 ± 0.49	
Residue Stone	Yes	5.23 ± 1.12	0.001
	No	3.22 ± 0.688	
Hydronephrosis	1	<sup>d</sup> 2.55 ± 0.393	0.001
	2	<sup>c</sup> 3.67 ± 0.74	
	3	<sup>b</sup> 5.52 ± 0.497	
	4	<sup>a</sup> 6.99 ± 1.55	

DJ: Double J; PULS: Post Ureterscopic Lesion Scale; <sup>a, b, c, d</sup>. There is a significant difference between groups with different letters.

**Table 3.** The correlation between stone size, operation duration, maximum ureteral wall thickness, and average ureteral thickness.

	Stone Size (mm)	Operation Duration (min)	Maximum Ureteral Wall Thickness (mm)	Average Ureteral Thickness (mm)
Stone Size (mm)	1			
Operation Duration (min)	0.613	1		
Maximum Ureteral Wall Thickness (mm)	0.554	0.622	1	
Average Ureteral Thickness (mm)	0.593	0.683	0.928	1

p<0.01; mm: milimeter; min: minute.

thickness at the point where the stone was located, and the average of four different thicknesses measured from the points 3-6-9-12 clockwise were taken, and the results were recorded (Figure 1).

The mean of maximum ureteral wall thickness was  $4.9 \pm 1.8$  (2.2-12.3) mm, while the mean of average ureteral wall thickness was  $3.81 \pm 1.24$  (1.91-9.03) mm. The mean operation duration was  $52.61 \pm 13.83$  (20-120) minutes. According to the average, and maximum ureteral wall thickness, PULS level, Dj insertion rate, HN level, and residual stone rate increase significantly (Table 1, 2).

The relationship between average, and maximum wall thickness, stone size, and operation duration is in Table 3.

### DISCUSSION AND CONCLUSION

The most frequently preferred minimally invasive method in the surgical treatment of ureteral stones is URS. However, URS is not free from complications and does not promise definitive treatment. URS has complications such as residual stone, retrograde migration of stone, hematuria, mucosal damage, laceration, and ureteral avulsion. Studies have reported that the impact of the stone affects the success of URS, ESWL, and spontaneous passage of the stone.<sup>6-10</sup> Many definitions have been established for impacted stone. The first is that the distal part of the stone cannot be visualized in intravenous pyelography (IVP). The second is that the stone stays in the same region for more than two months. However, the inability to take IVP in all patients due to allergy or kidney failure, it takes time, and the time when the stone first impacts are not known, limiting these definitions. In addition, in some studies, an impacted stone was defined as the embedding of the stone in the ureteral wall in endoscopic imaging or the inability to send the sensor guide to the proximal part of the stone retrogradely.<sup>11-13</sup> However, we did not use this

definition because both conditions are subjective, evaluate the ureteral wall only internally, and do not provide information about the outer part of the ureteral wall. In addition, in a study to investigate the effect of ureteral wall thickness in predicting impacted stone, and predicting the success of URS, the largest thickness of the ureteral wall was taken.<sup>8</sup> However, we think that evaluation with a single thickness is not sufficient. Because the ureteral stone is wrapped all around, not from a single point. In addition, the ureteral wall at one point may be wide, while the other walls may be relatively thin due to the focal infectious area. For this reason, in our study, we found it appropriate to study the average of four thicknesses obtained at 90-degree intervals, as well as the widest wall thickness.

The effect of the size of the stone in the spontaneous passage of ureteral stones is known. While stones with a size of <7 mm are expected to fall spontaneously, this expectation is reduced for stones with a diameter of >10 mm. While the passage of large stones in the ureter decreases, the probability of being stuck at one point increases. Due to staying in the same area for a long time, ureteral wall thickness increases due to local inflammation, secreted mediators, and focal infective areas.<sup>9,14</sup> Studies have reported that stone size is associated with increased ureteral wall thickness.<sup>11,12</sup> In our study, it was observed that both the maximum wall thickness, and the average wall thickness increased significantly as the stone size increased.

In the literature, it has been shown that the stone-free rate in patients who underwent ESWL decreased with increasing stone size and impact.<sup>11</sup> Although the stone-free rate after ESWL varies between 57-96%, this rate drops to 45-60% in the case of impacted stones. It has been reported that long-term embedded stones cause thickening of the ureteral wall, polyps, and mucosal inflammation. Increasing wall thickness allows limited space for

the ureter to expand during stone passage or ureteroscopy. This complicates ureteroscopy, and prevents the passage of post-op residual stones.<sup>5,11</sup> In addition, it can be predicted that the operation will be more difficult, and take longer in case of increased stone size and thicker ureteral wall thickness. Therefore, it can be thought that the complication rate will increase. However, Takashi Yoshida et al. in their study, did not find a relationship between ureteral wall thickness, and intraoperative (intra-op) complications.<sup>9</sup> However, this is a result that should be approached with hesitation. Because they considered only ureteral perforation, and avulsion as intra-operative complications in their study. However, URS complications are not limited to these two complications. A scale called PULS has been produced to classify URS complications.<sup>6,15-17</sup> In our study, we preferred to use PULS to evaluate complications of URS. In our study, we observed that both the maximum wall thickness, and the average wall thickness increased significantly with increasing stone size. In addition, increasing the average, and maximum wall thickness both decreased the stone-free rate, and increased the complication rate.

One of the limitations of our study is the relatively wide range of stone sizes. Studies investigating the effect of ureteral wall thickness independent of stone size on ureteroscopy are needed.

In conclusion, we revealed that ureteric wall thickness is a predictive factor for ureterorenoscopy to predict stone-free, DJ insertion, and complication rates. It can be useful for pre-op surgeons in predicting the perioperative clinical course, and informing their patients.

**Ethics Committee Approval:** Ethical approval was obtained from Van Yuzuncu Year University Interventional Clinical Research ethics committee (Date: 29.04.2021, decision no: 10). The study was performed following the Helsinki criteria. Written informed consent was obtained from all participating patients.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Author Contributions:** Concept – MD, İD, FD, KT, KK, MS; Supervision – RA, RE, KE, KT, MD, İD, FD, MS, KK; Materials – MD, KT, RE, RA, KE; Data Collection and/or Processing – RA, RE, KE, KT, MD, İD, FD, MS, KK; Analysis and/ or Interpretation – RA, RE, KE, KT, MD, İD, FD, MS,

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