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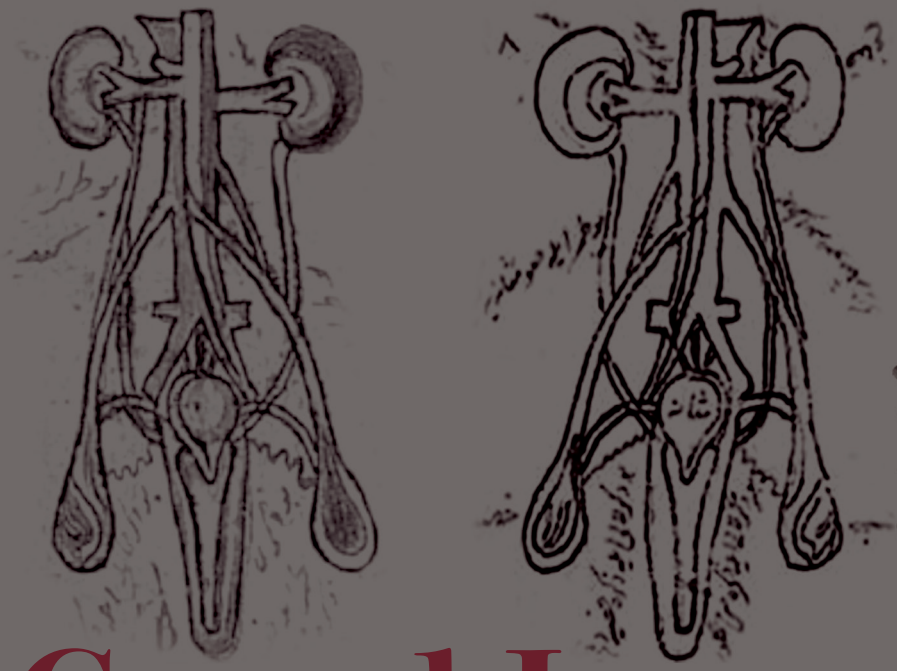

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[1] Guner E, Seker KG, Arikan Y, Huseynov C, Sam E, Ozdal OL. Aktuelle Urol. 2020; 51: 285-289. https://doi.org/10.1055/a-1117-2776.

- Article with more than six authors

[2] Karabulut D, Karabulut U, Caglar FN, Ekşi M, Yenice MG, Guner E, et al. The association between CHA2DS2-VASc score and erectile dysfunction: a cross-sectional study. Int Braz J Urol. 2019; 45: 1204-1208. https://doi.org/10.1590 / S1677-5538. IBJU.2019.0058.

- Book

[3] Sweetman SC. Martindale the Complete Drug Reference. 34th ed. London: Pharmaceutical Press; 2005.

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[4] McKenna K. Ejaculation. In: Knobil E, Neil J, editors. Encyclopedia of Reproduction, New York: Academic Press; 1999, p. 1002-8.

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Editorial

Dear colleagues,

I am honored to share with you the first issue of 2026 (volume 6, issue 1) of the Grand Journal of Urology (Grand J Urol) with the contributions of many respected researchers and authors.

Grand Journal of Urology (GJU) aims to carry written and visualscientific urology studies to academic platforms and to make significant contributions to the science of urology. Our journal has been abstracted/indexed in Tubitak Ulakbim TR Index, EBSCOhost, J-Gate, SciLit, ResearchGate and Google Scholar international databases. As of these achievements, the Grand Journal of Urology (GJU) has taken its place among the journals indexed by national and international databases.

In this issue of our journal, there are many valuable articles under the subheadings of Andrology, Endourology, General Urology, Laparoscopic and Robotic Surgery, Pediatric Urology, Reconstructive Urology and Urologic Oncology. I hope that these carefully prepared articles will make important contributions to valuable readers, researchers and the urology literature.

On this occasion, I would like to express my heartfelt gratitude to our authors who have contributed to our journal with their articles, to our reviewers who have meticulously evaluate the articles.

Respectfully yours

January 2026

Assoc. Prof. Ekrem GUNER, MD

Editor-in-Chief

Original Article – Pediatric Urology
Grand J Urol 2026;6(1):1-6
DOI: 10.5505/GJU.2026.00922

Testicular Microlithiasis in Pediatric Patients

Pediatrik Hastalarda Testiküler Mikrolitiazis

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Abstract

Objective: Testicular microlithiasis (TM) is characterized by parenchymal calcifications, identified as hyperechoic, shadowless foci measuring between 1 and 3 mm in diameter within the testicular parenchyma. This condition is typically detected incidentally through ultrasonography in rare inguinal-scrotal disorders in pediatric patients. TM has been linked to various pathological conditions of the testis, notably an elevated risk of tumor development. A retrospective review of TM cases was conducted to assess clinical features and long-term follow-up outcomes.
Materials and Methods: This retrospective analysis was conducted over a 12-year period involving children diagnosed with TM through scrotal Doppler ultrasonography at our outpatient clinic. Medical records were examined to evaluate patient age, indications for ultrasound, associations with inguinal-scrotal pathologies, and follow-up findings.
Results: In this study, fifty-six patients aged between 2 and 17 years (median age of 9 years) were included. Bilateral TM was observed in all cases, except for 15 patients who exhibited unilateral foci. Among the participants, 27 patients (48.2%) presented with concomitant inguinal-scrotal pathology, while 3 patients (5.3%) had systemic disease. Notably, microlithiasis and Leydig cell tumors were identified in one patient who underwent ultrasonography due to testicular pain.
Conclusion: TM is predominantly bilateral and of the classic type, with testicular pain potentially indicating its presence. Ultrasonography is generally adequate for both the diagnosis and monitoring of testicular microlithiasis. An association with testicular tumors is noted, particularly within the pediatric population. Given that both benign and malignant lesions are linked to TM, studies involving larger populations and extended follow-up periods are warranted.

Keywords: child, Leydig cell tumor, testicular microlithiasis, ultrasonogrphy

Özet

Amaç: Testiküler mikrolitiazis (TM), testiküler parankim içinde çapı 1 ila 3 mm arasında değişen hiperekoik, gölgesiz odaklar olarak tanımlanan parankimal kalsifikasyonlarla karakterizedir. Bu durum tipik olarak çocuk hastalarda nadir görülen inguinal-skrotal bozukluklarda ultrasonografi yoluyla tesadüfen tespit edilir. TM, başta yüksek tümör gelişimi riski olmak üzere testisin çeşitli patolojik durumlarıyla ilişkilendirilmiştir. Klinik özellikleri ve uzun dönem takip sonuçlarını değerlendirmek için TM olgularının retrospektif bir incelemesi yapılmıştır.
Gereçler ve Yöntemler: Bu retrospektif analiz, kliniğimizde skrotal Doppler ultrasonografi ile TM tanısı konulan çocukları içeren 12 yıllık bir süre boyunca gerçekleştirilmiştir. Hasta yaşı, ultrason endikasyonları, inguinal-skrotal patolojilerle ilişkileri ve takip bulgularını değerlendirmek için tıbbi kayıtlar incelendi.
Bulgular: Bu çalışmaya yaşları 2 ile 17 arasında değişen (ortanca yaş 9) elli altı hasta dahil edildi. Tek taraflı odak gösteren 15 hasta dışında tüm olgularda bilateral TM gözlendi. Katılımcılar arasında 27 hastada (%48,2) eşlik eden inguinal-skrotal patoloji mevcutken, 3 hastada (%5,3) sistemik hastalık vardı. Özellikle, testis ağrısı nedeniyle ultrasonografi yapılan bir hastada mikrolitiazis ve Leydig hücreli tümörler tespit edildi.
Sonuç: TM ağırlıklı olarak bilateral ve klasik tipte olup, testis ağrısı potansiyel olarak varlığını gösterir. Ultrasonografi testiküler mikrolitiazisin hem tanısı hem de takibi için genellikle yeterlidir. Özellikle pediatrik popülasyonda testis tümörleri ile bir ilişki kaydedilmiştir. Hem iyi huylu hem de kötü huylu lezyonların TM ile bağlantılı olduğu göz önüne alındığında, daha geniş popülasyonları ve uzun takip sürelerini içeren çalışmaların yapılması gerekmektedir.

Anahtar kelimeler: çocuk, Leydig hücreli tümör, testis mikrolitiazisi, ultrasonografi

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Introduction

Testicular microlithiasis (TM) is a pathological condition characterized by diffuse calcification within the seminiferous tubules [1,2]. Research on TM in pediatric populations is limited, and its association with testicular disease in children remains a subject of debate. [2,3,4]. TM is observed in 1.1-4.2% of asymptomatic males without urological disorders [3,4,5]. In the testicular parenchyma, it is usually detected by US and is typified by hyperechoic non-shadowing foci that are 1-3 mm in diameter. Although the exact cause of calcified material inside seminiferous tubules is unknown, several theories have been proposed, including inflammation, poor Sertoli cell phagocytosis, excessive immunological response, and rapid cell renewal [6]. Epidemiological studies have indicated an increased prevalence of TM in patients with risk factors for testicular tumor development. Its association with various benign or malignant pathologies has been documented, particularly testicular germ cell tumors, cryptorchidism, testicular torsion or atrophy, gonadal dysgenesis, varicocele, Klinefelter's syndrome, Down's syndrome, infertility, male pseudo-hermaphroditism, carcinoma in situ, and a family or personal history of testicular cancer [7,8].

In asymptomatic patients, TM is typically identified incidentally during routine medical examinations or US performed for other diagnostic purposes. Symptomatic TM is defined as the presence of microliths on US, accompanied by testicular pain, testicular edema, increased testicular size, hydrocele, varicocele, or testicular atrophy, which can occur at any age [9,10].

We performed a retrospective analysis of the clinical characteristics, comorbidities, follow-up, and outcomes of patients with TM as observed on scrotal US. The objective of this study was to examine the relationship between TM and histopathological findings.

Materials and Methods

A retrospective analysis was conducted on 2.350 pediatric patients who presented with symptoms of testicular pain, scrotal swelling, and erythema at our outpatient clinic. These patients underwent scrotal US between January 2013 and December 2024. Doppler ultrasonography reports are documented within the hospital information system. The study included 56 patients diagnosed with TM, each of whom underwent a minimum of two scrotal US procedures. During the US examination, the number and distribution pattern of testicular calcifications were assessed, with echogenic foci measuring less than 1-3 mm in a single plane and lacking acoustic shadowing being included. Additionally, the calcifications were categorized as diffuse or focal, bilateral or unilateral, and with or without associated nodules. Patients diagnosed with TM and monitored over time were evaluated concerning age, indications for US, association with inguinal-scrotal pathology, and follow-up findings. This study was conducted according to Kocaeli University Faculty of Medicine Ethics Committee (Decision date and number; GOKAEK-2025/08/09- E-80418770-020-765346).

Table 1. Patients' symptoms and associated diagnosis with testicular microlithiasis

Patients	%	Presenting symptoms and associated diagnosis
20	35.7	Painful testis
10	17.8	Acute scrotum
9	16.0	Incidental
8	14.2	Undescended/retractile testis
4	7.1	Hydrocele
2	3.5	Varicocele
2	3.5	Epididymal cyst
1	1.8	Benign tumor

Table 2. Systemic diseases with testicular microlithiasis

Patients	Systemic diseases
2	hypothyroidism
1	rheumatoid arthritis

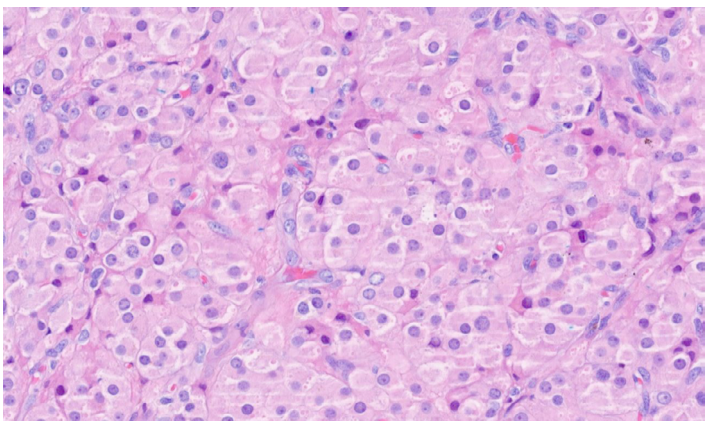

Figure 1. Tumor cells with eosinophilic large cytoplasm and round vesicular nucleus (H&E X40)

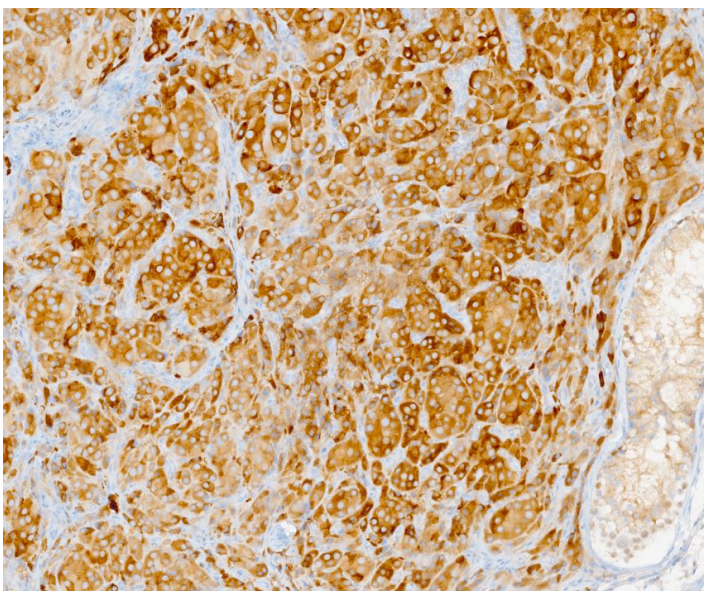

Figure 2. Inhibin positivity in tumor cells (Immunohistochemistry DABX20)

Statistical Analysis

The statistical analysis was carried out using the latest version of IBM SPSS 29.0. The Kolmogorov-Smirnova test was employed to assess the normality of the data distribution, and it was found that the assumption of normal distribution was not met. Categorical variables are presented as frequencies (percentages), whereas numerical variables are reported as the median with the interquartile range (25th-75th percentile).

Results

The diagnosis of TM was established using US in all patients, with a prevalence of 2.3% among children. The patients had a median age of 9 years, with ages ranging from 2 to 17 years. TM was predominantly diffuse and bilateral (n=40, 71.4%), while unilateral TM was observed in 16 male patients (right: 6, left: 10), most frequently occurring in the 7-10 year age group (n=21, 37.5%). Twenty-seven patients (48.2%) presented with concomitant inguinal-scrotal pathologies (**Table 1**), and 3 patients (5.3%) had concurrent systemic diseases (**Table 2**).

Patients were invited to undergo US examinations at least annually following their diagnosis. The median follow-up duration was 3.5 years, with a range of 1 to 8 years. During the follow-up of 32 patients without inguinoscrotal pathology, no new pathological findings were identified. Nine patients underwent inguinoscrotal surgery (undescended testis, n=6; acute scrotum, n=3). Orchiectomy was performed in three patients (5.3%): two due to testicular torsion and one due to testicular atrophy following surgery for an undescended testis. In one case, TM was identified during the diagnosis of a testicular mass on the same side. This patient was diagnosed with a Leydig cell tumor following biopsy and subsequently underwent testicular-sparing surgery (**Figure 1,2**). No recurrence was observed at the mean follow-up of 2 years.

Discussion

The precise etiology of TM, a pathological condition, remains unidentified. It is thought to result from the seminiferous epithelium's degeneration, which then spreads into the tubular lumen. Some researchers suggest that the development of microliths may result from malfunctioning Sertoli cells, potentially linked to abnormal gonadal embryogenesis [11]. Priebe and Garret documented radiographs of a healthy 4-year-old boy exhibiting TM, which was subsequently diagnosed by Doherty et al. in 1987 using ultrasonography [12,13].

The prevalence of TM in the pediatric and adult male populations ranges from 1.1% to 5.6% [5,10,14]. In our study, the incidence of TM among patients undergoing scrotal ultrasound for testicular pathology was 2.6%, aligning with existing literature.

TM is characterized by hyperechogenic foci of varying degrees within the testicular parenchyma, typically distributed bilaterally throughout the testes [3]. Diffuse testicular dysgenesis is associated with TM, which typically measures 1-2 mm in diameter on US . Both unilateral and bilateral TM are possible, as is a diffuse or localized distribution of calcifications [15,16]. In our study, a focal distribution was observed in sixteen cases (28.6%), while a diffuse distribution was noted in 40 cases (71.4%) of the ultrasound images diagnostic of TM. With the exception of two individuals who underwent unilateral orchiectomy, the calcifications were observed bilaterally.

Although TM is traditionally considered a static condition that neither progresses nor regresses over time, a limited number of studies have documented instances of increase, decrease, or complete resolution of the condition during patient follow-up [14].

Pain constitutes the primary cause for hospital admissions among children with TM [1,17]. Nonetheless, several studies have not reported on testicular pathology in individuals experiencing pain and TM diagnosed via ultrasound (US) [1,2,17]. In our study, TM was incidentally identified in 9 patients (16.0%), associated with pain in 20 patients (35.7%), and accompanied by inguinal-scrotal pathology, as detailed in **Table 1**, in 27 patients (48.2%). Our findings align with previous research, indicating an increased prevalence of TM in testicular pathology. TM may appear without patient-reported symptoms or may itself be the origin of pain.

The prevalence of TM may be heightened in benign illnesses such Klinefelter's syndrome, cryptorchidism, Down syndrome, hypospadias, and post-traumatic scenarios [5,9,18,19].

In our study, eight patients presented with undescended testes, ten with an acute scrotum, and two with epididymal cysts. Research has indicated that undescended testes are correlated with an increased prevalence of TM [2,19,20]. The prevalence of TM in an asymptomatic group, on the other hand, is similar to that seen in patients with undescended testes, according to research by Chiang and Pedersen et al [14,17]. In our analysis, six patients with cryptorchidism exhibited ipsilateral TM, while two presented with contralateral TM. All six patients underwent orchidopexy to address undescended testes at the age of one year. The etiology of TM remains uncertain, as it is unclear whether it is a consequence of cryptorchidism or if both cryptorchidism and TM are manifestations of tubular abnormalities. Additionally, it is plausible that surgical intervention itself may induce TM, or that it arises due to vascular damage to the testis.

The precise correlation between TM and both benign and malignant conditions remains undetermined, particularly within the pediatric demographic [5,9,21]. According to extant literature, the prevalence of TM in children presenting with potential risk factors for primary testicular tumors (TT)—such as testicular pain, testicular masses, personal or familial history of TT, or undescended testis—ranges from 0.7% to 12%, and may reach up to 4.2% in asymptomatic children [1,5,22]. The age range of pediatric cases documented in the literature spans from 2 to 17 years. Pediatric instances of TM associated with tumors include gonadoblastoma, yolk sac germ cell tumor, metastatic mixed germ cell tumor, Leydig cell tumor, teratoma, choriocarcinoma, Sertoli cell tumor, and benign metachronous epidermal cyst [23].

Leydig cell tumors constitute up to 5% of testicular neoplasms and can occur across all age groups [24,25]. Approximately 20% of these tumors manifest between the ages of five and ten. In the present study, an 11-year-old patient was diagnosed with microlithiasis and a Leydig cell

tumor and subsequently underwent testicular-sparing surgery. No recurrence was observed at the four-year follow-up. The diagnosis of a testicular tumor with microlithiasis was confirmed via ultrasound (US). Consequently, it cannot be conclusively stated that microlithiasis serves as a precursor lesion. However, literature reports a case of a 20-year-old patient with Down syndrome who developed a Leydig cell tumor due to microlithiasis over a four-year follow-up period [26]. Our patient did not present any additional conditions that could serve as risk factors, such as Down syndrome, McCune-Albright syndrome, gonadal dysgenesis, or undescended testes.

As TM is typically an incidental finding in the absence of associated risk factors, the European Association of Urology (EAU) and the European Society for Pediatric Urology (ESPU) guidelines do not advocate for routine US in cases of undescended or palpable testes [9]. Testicular microlithiasis (TM) is also associated with testicular pathologies, including testicular tumors and cryptorchidism. Consequently, it is imperative to exercise caution when managing patients presenting these risk factors. However, they do recommend regular follow-up with US, particularly if there is a family history of testicular malignancy, testicular pain, testicular enlargement, or Down's syndrome [2].

Previous studies have demonstrated that the determination of tumor markers or the performance of testicular biopsy in pediatric patients with TM does not provide additional clinical value, as it lacks clinical implications [9]. We did not routinely conduct tumor marker assessments in patients monitored with a diagnosis of TM. However, in the case of our patient diagnosed with a Leydig cell tumor, tumor markers, specifically AFP and B-HCG, were evaluated and subsequently returned to normal levels.

In the majority of studies, the reported follow-up period did not extend beyond adolescence, even in the presence of risk factors. The longest follow-up duration of seven years may be insufficient to detect testicular malignancies. In cases where a patient presents with isolated testicular microlithiasis (TM) but lacks identifiable risk factors, yet exhibits clinical symptoms, we advise conducting follow-up imaging at one-year intervals. It is crucial for patients to perform monthly testicular self-examinations during this period. For patients with risk factors such as cryptorchidism, infertility, testicular atrophy, and particularly a family or personal history of germ cell tumors, we recommend more frequent scrotal ultrasound examinations. Future research in the pediatric population would benefit from focusing on distinguishing cases of benign microlithiasis from those with a higher risk of malignant transformation. Incorporating a larger sample size and conducting longer studies with regular ultrasound surveillance may provide conclusive evidence regarding whether testicular microlithiasis in children is benign or premalignant.

The psychological impact of a TM diagnosis on children and their families is frequently an overlooked aspect of care. It is imperative that the emotional and developmental concerns of both parents and patients are more effectively addressed during follow-up care.

Of course, our study had some limitations. The limitations of our study were the retrospective nature of the study, the small number of patients and the short follow-up period.

Conclusion

TM is a rare and contentious condition frequently associated with various inguinoscrotal disorders. Long-term monitoring of TM cases is essential for the early detection of concomitant tumor development, particularly in the presence of predisposing conditions and accompanying undescended testes. Elevated TM levels may suggest an increased risk of malignancy and may guide decisions regarding imaging or surgical interventions. In this study, only one tumor lesion associated with TM was identified. Given the documented association between tumor lesions and TM in the literature, we assert that a long-term, multidisciplinary approach involving pediatric surgeons and urologists is warranted.

Ethics Committee Approval: Ethical approval for this study was obtained from Kocaeli University Faculty of Medicine Ethics Committee before the study (Decision date and number; GOKAEK-2025/08/09- E-80418770-020-765346).
Informed Consent: An informed consent was obtained from all the patients.
Publication: The results of the study were not published in full or in part in form of abstracts.
Peer-review: Externally peer-reviewed.
Authorship Contributions: Any contribution was not made by any individual not listed as an author. Concept –O.V., M.A.A.; Design –O.V., M.A.A.; Supervision –O.V., Y.A.; Resources –O.V.; Materials –O.V., M.A.A., N.G.S., Y.A.; Data Collection and/or Processing –O.V., M.A.A., N.G.S; Analysis and/or Interpretation –O.V., M.A.A.; Literature Search –OV, M.A.A., Y.A.; Writing Manuscript –O.V., ; Critical Review –O.V, M.A.A.
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Effect and Results of Retrograde Intrarenal Surgery in Pediatric Patients According to Stone Size and Location

Çocuk Hastalarda Böbrek Taşı Boyutu ve Yerleşimine Göre Retrograd İntrarenal Cerrahinin Etkisi ve Sonuçları

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Abstract

Objective: We aimed to evaluate the outcomes of RIRS according to kidney stone location and size of kidney stones in the pediatric population.
Materials and Methods: A total of 32 pediatric patients with upper urinary tract stones with 40 renal units were investigated in terms of stone size and location. Stone location, gender, stone size, stone Hounsfield unit, preoperative stenting, access sheath size, complication, length of hospital stay, and stone-free rates were retrospectively analyzed. Patients were divided into two groups. The first group patients of had stones smaller than 2cm, and the second group who had stones larger than 2 cm.
Results: The mean age of the patients in Group 1 was determined as 10,8 (4-17) years, and the mean age of Group 2 was determined as 15,1 (10-17) years. The age difference was statistically significant (p= 0.003). There was no statistically significant difference in gender distribution (p= 0.289). The average stone size of Group 1 was measured as 12,6 mm (11-17), and the Group 2 stone size was measured as 25,2 mm (20-43) on average. In terms of operation times, the average operation time in Group 1 was 48 (30-70) minutes, and the average operation time in Group 2 was 65 (40-95) minutes, and a statistically significant difference was observed (p= 0.015). In the first group, the stone-free rate in a single session was 76.3%, and in the second group, the stone-free rate in a single session was 62%. There was no statistically significant difference between the groups in terms of stone-free rates (p= 0.295).
Conclusion: RIRS is a method that can be used safely and effectively in pediatric patients with kidney stones smaller than 2 cm, with high stone-free rates. Although; the stone-free rate was lower in stones larger than 2 cm compared to those smaller than 2 cm, this difference was not statistically significant.

Keywords: upper urinary system stones, pediatric urolithiasis, retrograde intrarenal surgery, stone-free rate

Özet

Amaç: Bu çalışmada, pediatrik popülasyonda böbrek taşı lokalizasyonu ve boyutuna göre RIRC etkilerini ve sonuçlarını değerlendirmeyi amaçladık.
Gereçler ve Yöntemler: Üst üriner sistem taşına sahip toplam 32 pediatrik hasta ve 40 renal ünite, taş boyutu ve lokalizasyonu açısından incelendi. Taş lokalizasyonu, cinsiyet, taş boyutu, taşın Hounsfield ünitesi, preoperatif stentleme, erişim kılıfı boyutu, komplikasyonlar, hastanede kalış süresi ve taştan tamamen kurtulma oranları retrospektif olarak analiz edildi. Hastalar taş boyutuna göre iki gruba ayrıldı. Birinci grup, 2 cm'den küçük taşlara sahip hastaları; ikinci grup ise 2 cm'den büyük taşlara sahip hastaları içermektedir.
Bulgular: Renal ünite bazında değerlendirildiğinde, Grup 1 hastalarının ortalama yaşı 10,8 (4-17) yıl, Grup 2 hastalarının ortalama yaşı ise 15,1 (10-17) yıl olarak belirlendi. Yaş farkı istatistiksel olarak anlamlıydı (p= 0,003). Cinsiyet dağılımında istatistiksel olarak anlamlı bir fark saptanmadı (p= 0.289). Grup 1'in ortalama taş boyutu 12,6 mm (11-17), Grup 2'nin taş boyutu ise ortalama 25,2 mm (20-43) olarak ölçüldü. Operasyon süresi açısından, Grup 1'in ortalama ameliyat süresi 48 (30-70) dakika, Grup 2'nin ise 65 (40-95) dakika olup, istatistiksel olarak anlamlı bir fark bulundu (p= 0.015). İlk grupta tek seansta taşsızlık oranı %76,3, ikinci grupta ise %62 olarak belirlendi. Taşsızlık oranları açısından gruplar arasında istatistiksel olarak anlamlı bir fark yoktu (p= 0.295).
Sonuç: RIRS, 2 cm'den küçük böbrek taşlarına sahip pediatrik hastalarda yüksek taşsızlık oranları ile güvenli ve etkili bir yöntem olarak kullanılabilir. 2 cm den büyük taşlardan taşsızlık oranları 2 cm den küçük taşlara kıyasla düşük olsa da verilerimizde istatistiksel anlamlı olarak saptanmamıştır.

Anahtar kelimeler: üst üriner sistem taşları, pediatrik ürolitiazis, retrograd intrarenal cerrahi, taşsızlık oranı

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Introduction

Childhood (<18 years) urinary system stones are seen with a frequency of 1-2% in society. In recent years, the incidence of pediatric stones has increased especially in adolescence due to carbohydrate-rich diet, high salt consumption and sedentary lifestyle. In younger children, kidney stones are less common and are more likely to occur for metabolic or anatomical reasons, and can recur more frequently and earlier [1]. Today, with technological advances, the miniaturization of endoscopic instruments and the development of non-invasive methods, high success can be achieved in pediatric stone surgery, especially in difficult cases [2]. Pediatric patients with stones larger than 5 mm have a lower probability of spontaneous passage and need treatment [3]. Among these treatments, extracorporeal shock wave lithotripsy (ESWL) is a non-invasive treatment that has been used safely and successfully in adults for a long time and it is known that children respond better to ESWL than adults [4,5]. In addition, with the development of technology and the increased access to miniature instruments, methods such as retrograde intrarenal surgery (RIRS), ureterorenoscopy (URS), and percutaneous nephrolithotomy (PNL) can be applied succesfully in pediatric patients. In these operations, in addition to surgical instruments, factors such as the location of the stone, its size and the Hounsfield unit (HU) may also affect stone-free rates. Although ESWL is considered the first choice for treatment of stones up to 20 mm, the fact that the procedure is performed under general anesthesia and requires multiple sessions may limit the use of ESWL in children due to low success in metabolic stones (cystine) [6,7]. On the other hand, studies have shown the safe use of RIRS even in infants <1 year old [7].

Although mini PNL seems to be more successful than retrograde intrarenal surgery in terms of stone-free rates in stones between 10 mm and 20 mm and larger than 20 mm, RIRS can be recommended as an alternative for stones larger than 20 mm [8]. With technological advances, thin instruments, image quality and the development of instruments with increased deflection ability, the preference for retrograde intrarenal surgery for most stones in all localization of the kidneys is increasing. In this study we aimed to examine the effects and results of retrograde intrarenal surgery according to the location and size of kidney stones in pediatric population.

Material and Methods

After obtaining ethical approval from the Clinical Research Ethics Committee (Date: 09.04.2025 No: 2025/380), between 2018 and 2024 a total of 32 patients under the age of 18 years and 40 renal units who underwent retrograde intrarenal surgery were included in the study. Patients were divided into 2 groups according to stone size. There were 25 renal units with a size of less than 20 mm in the first group and there were 15 renal units with a size of more than 20 mm in the second group.

In addition, patient demographics, stone localization, age, gender characteristics, HU of the stones, preoperative ureteric double J (JJ) stenting, use of access sheath, and stone-free rates were retrospectively analyzed.

Before the operation, computed tomography and ultrasonographic images of the patients were examined. The patients' operative information was obtained from the hospital database and their records were obtained. After the operation, the patients' follow-up ultrasonography and direct urinary system radiographs were investigated.

Operations were performed using a 4.5/6.5 Fr ultrathin semi-rigid ureterorenoscope (Richard Wolf, Germany) and a fiberoptic reusable flexible ureteroscope (Karl Storz Flex-X2, Germany). Stones were broken with a 30W holmium- YAG laser (Litho, Quanta, Milano, Italy), 9.5/11.5 Fr access sheath (Plastimed, Istanbul, Turkey) was used. JJ stents (Plastimed, Istanbul, Turkey) appropriate to the age and height of the patients were used.

All data were calculated using IBM SPSS Version 23.0 statistical package program (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp). Continuous variables were found as mean ± standard deviation (median, minimum, maximum) values and categorical variables were found as numbers and percentages. The Mann-Whitney U test was used to compare continuous variables between two groups, and the Chi-square test and Fisher's exact chi-square test were used to compare categorical variables. Statistical significance level was accepted as "$p<0.05$".

Results

According to the stone size, the patients were divided into 2 groups; the mean age of the first group was 10.8 (4-17) years, and the second group was 15.1 (10-17) years, and the age difference was statistically significant (p= 0,003). No statistically significant difference was found in terms of gender distribution of the patients p=0.289. According to the renal unit, 25 patients had stones smaller than 20 mm, and 15 had stones larger than 20 mm. [**Table 1**]

While lower calyceal stones were most frequently seen in group 1 (40%), renal pelvis stones were most frequently seen in group 2 (40%). There was no statistically significant difference in stone location between the groups (p= 0.294). [**Table 2**]

Preoperative JJ stents were placed for passive dilatation in 17 renal units (68%) in the first group and in 8 renal units (53.3%) in the second group. RIRS procedures of these patients were planned for later sessions. No statistically significant difference was observed between the two groups in terms of stent placement (pre-stenting) for passive dilatation of the ureter before the procedure (p=0.315). During RIRS, access sheaths were used during surgery in 18 renal units (72%) in the first group and in 13 renal units (86.6%) in the second group. No statistically significant difference was observed between the groups in access sheath use (p = 0.122). According to stone size, the stone-free rate in a single session was 76.3% in the first group and 62% in the second group, and no statistically significant difference was observed (p=0.295). The average HU of the stones was measured as 844.9 (min: 233-max: 2100) in the first group; and the average HU was 795 (min: 210-max: 2015) in the second group, and no statistically significant difference was observed between the stone-free rates in terms of HU between the two groups. (p= 0,340) [**Table 3**]

Table 1. Distribution of patients according to age, gender and stone size

Stone size	Group 1 (n: 25) <20 mm	Group 2 (n:15) >20 mm	P value
Girl	12 (%48)	10 (%66,7)	
Boy	13 (%52)	5 (%33,3)	
Age	10,8 (4-17) year	15,1 (10-17) year	**0,003**
Stone size mm	12,6 (11-17)	25,2 (20-43)	**0,012**
Operation time	48 (30-70) min	65 (40-95) min.	**0,015**
Stone free rate	76,3%	62%	0,295

Table 2. Distribution of stones according to localization

Renal unit	Group 1 (n:25)	Group 2 (n:15)
Renal pelvis	6 (24%)	6 (40%)
Upper calyx	3 (12%)	-
Middle calyx	2 (8%)	1 (67,7%)
Lower calyx	10 (40%)	4 (26,7%)
Proximal ureter	3 (12%)	-
Multiple	1 (4%)	4 (26,6%)

Table 3. Number of renal units of stones, Hounsfield units and stone-free rate, use of prestenting and acces sheaths

Renal units	Group 1 (n=25)	Group 2 (n=15)	P value
Operation time	48,88±8,75	65,66±17,58	**0,015**
Acces sheat	18 (72%)	13 (86,6%)	0,122
Prestenting JJ	17 (68%)	8 (53,3%)	0,315
HU (Hounsfield unit)	844,9 (min:233-max: 2100)	795 (min:210-max:2015)	0,340
Stone free rates	76,3%	62%	0,295

Discussion

Over the years, the development of flexible ureteroscopes (f-URS) and fiberoptic systems, and the simultaneous use of laser technologies, have enabled the successful retrograde fragmentation of kidney stones. It was first described by Huffman et al. in 1983 with the fragmentation of kidney stones using a rigid rod-lens structured ureteroscope and an ultrasonic lithotripter, and in 1990, Fuchs et al. published the first series of RIRS using f-URS [9,10]. ESWL, RIRS and PNL are recommended in the treatment of urinary system stone diseases in children

As a minimally invasive technique, ESWL was initially used in adults, but it was not initially applied to pediatric patients because it was thought to have a negative effect on child development. ESWL can achieve high stone-free success rates, especially for stones smaller than 10 mm, depending on the stone type, size, location, and urinary tract anatomy [11]. ESWL is recommended as the primary treatment for lower-pole stones smaller than 10 mm and other upper-system stones smaller than 2 cm in children [12]. However, although ESWL achieves success rates of 75-92% in pediatric patients, studies have shown that stone-free rates after ESWL for stones <10 mm are 100%, whereas this rate decreases to 66.6% for stones>20 mm [13]. There are also studies suggesting be negative effects on kidney development after ESWL in pediatric patients [14].

Although the length of hospital stay and complication rates are lower after ESWL, the possibility of additional interventions is higher after ESWL. In a recent prospective study by Mokhles et al., the results of ESWL and RIRS for 10-20 mm stones in preschool children were compared, and the overall stone-free rates were found to be 93% and 96% respectively [6]. According to this result, ESWL is recommended for stones up to 20 mm. The fact that the procedure requires general anesthesia in repeated sessions in children, is associated with renal scarring, hypercalciuria, hypertension and chronic renal failure in the long term, and stones such as cystine stones do not respond adequately to treatment limits the use of this technique in children [6,15]. In addition, while patients who underwent ESWL required multiple sessions, very few patients who underwent RIRS required additional interventions later on [16]. In this study, it was reported that medium-sized stones in children under 6 years of age could be broken safely with RIRS. Another method for the treatment of kidney stones in children is percutaneous nephrolithotomy. With technological developments, Mini-PNL using small instruments between 11Fr and 21 Fr and recently Micro-PNL using a 4.8Fr nephroscope can be successfully performed. In a meta-analysis of 7 studies, 280 micro-PNL and 259 RIRS patients were compared and although stone-free rates were found to be higher in patients who underwent PNL, overall complication rates were found to be higher. Desai et al. reported that intraoperative bleeding during PNL is related to the diameter of the tract and should not exceed 22Fr in children [17]. Mini, ultramini, and micro modifications are used to reduce the risk of complications, and despite all modifications and high success, major risks, organ injuries, urosepsis, and severe bleeding are seen up to 10% [18].

Today, with advances in endoscopy, the RIRS technique is widely used in many centers. Many studies have shown that

ureterorenoscopy in children does not carry significant risks such as ureteral stricture and reflux. RIRS is applied in children, with stone-free rates ranging from 60% to 100% depending on the stone's location and burden. In a large series of publications, it has been reported that lower-pole calyx stones up to 20 mm in size can be broken with a 94% stone-free rate with multiple additional attempts without the use of an access sheath [19]. In our study, lower calyceal stones were detected in 14 patients with a stone-free rate of 61.2% after a single intervention.

In a study conducted by Smaldone et al. Examining 100 patients, the average age was 13.2 years, the average stone size was 8.2 mm, and stones located in the upper pole, pelvis and lower pole were broken with a 92% stone-free rate [20]. In our study, stone-free rates were found to be 76.3% in the first group and 62% in the second group according to stone size, and no statistically significant difference was found (p=0.295). In the literature, it has been reported that stone-free rates depend on the size of the stone, regardless of its localization, and that additional intervention may be required, especially for stones larger than 6 mm [21]. Complication rates are low in retrograde intrarenal surgery and perforation has been reported between 0-4% in many studies [22]. In our study, no perforation developed in the patients. Although there is insufficient data on the routine use of preoperative JJ stents, no significant difference in stone-free rates or complications was observed in retrospective studies [23]. Hubert and Palmer have shown that previously inaccessible ureters in pediatric patients can be accessed by passive dilation with a JJ stent [24]. In our study, preoperative JJ stent placement (prestenting) was applied to 25 renal units for passive dilatation of the ureter before the procedure. When the patients who underwent passive dilatation and those who did not undergo it were examined in terms of stone-free status and complications, no statistically significant difference was observed between the two groups of patients. Another controversial issue is the use of access sheath. There are discussions about the possibility that the use of thick access sheaths may impair ureteral blood circulation. Studies show that a safer wide-lumen access sheath can be used by performing passive dilatation before insertion, thus providing a wider view [25]. In the study by Smaldone et al., 54% of patients underwent preoperative passive dilatation, and 24% used an access sheath. As a result of the study, no correlation was found between passive dilatation or access sheath use and complications [20]. In our study, an access sheath was used in 31 patients. No statistically significant difference was found in terms of stone free rate and complications.

The HU, which reflects stone density, is another modality that indicates the success of the treatment as well as the stone's size and intrarenal localization. In the study conducted by Quizad et al., the HU of 50 patients was measured and the threshold value was determined as 970, and the success rate after ESWL treatment for stones with HU <970 was 96%, and for stones with HU>970, the success rate was 36% [26]. The HU value of the stones can also affect the PNL results. Gücük et al. found that HU values of stones in 179 patients who underwent PNL were an independent factor affecting PNL success [27].

In a multicenter study, it was determined that stone size and localization were predictive factors for residual fragments in retrograde intrarenal surgery, independent of stone density [28]. In our study, the effect of stone density on stone-free rates was not found to be statistically significant. Similarly, stone size was also not found to have a significant impact on stone-free outcomes in the pediatric population.

In a study by Türedi and colleagues comparing conventional access sheaths with suction-assisted access sheaths, higher stone-free rates were reported with the use of suction-assisted access sheaths. However, this study did not evaluate stone-free rates specifically in patients with stones larger than 2 cm. Investigating stone-free rates in this patient group would provide clearer insight into the benefits of suction-assisted access sheaths for stones over 2 cm [29]. In our study, data from 15 renal units with stones larger than 2 cm treated using conventional access sheaths may serve as a reference for future evaluations of patients treated with suction-assisted access sheaths.

In the current studies in the literature, we see that especially medium-sized stones can be successfully broken with retrograde intrarenal surgery in preschool children. Although our study was conducted with a small number of patients, it supports the fact that retrograde intrarenal surgery can be used safely and effectively with low complication rates in the pediatric population. Future studies could be designed to compare outcomes in pediatric patients with stones larger than 2 cm with those in whom suction-assisted access sheaths were utilized, to better evaluate the effectiveness and safety of this approach in managing larger stone burdens.

Conclusion

According to the results of our study, RIRS can be safely performed in children with low complication rates. However, in cases of lower pole and large-sized stones, surgical success rates tend to decrease and may require additional interventions. Stone-free rates were found to be high in stones smaller than 20 mm, and due to its low complication rates, RIRS can be safely used in the pediatric population. With the advancement of technology, the miniaturization of instruments, improved maneuverability, the use of suction-assisted access sheaths, and enhanced image quality, we believe that RIRS may also become a first-line treatment option for stones larger than 2 cm.

Ethics Committee Approval: Ethical approval for this study was obtained from Mersin University Clinical Research Ethics Committee (Date: 09.04.2025 No: 2025/380).
Informed Consent: An informed consent was obtained from all the patients.
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Chatbots in Urology: A Bibliometric and Trend Analysis of the Emerging Landscape (2023-2025)

Ürolojide Sohbet Robotları: Gelişen Alanın Bibliyometrik ve Trend Analizi (2023-2025)

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Abstract

Objective: Chatbot applications powered by large language models (LLMs) have garnered growing interest in healthcare, including urology. Although recent studies suggest potential roles in patient education, decision support, and medical training, no bibliometric analysis has yet evaluated the research landscape within urology. This study aims to comprehensively reveal the current research trends and scientific contributions related to chatbots in urology.
Materials and Methods: A comprehensive bibliometric analysis was conducted using the Web of Science Core Collection (Urology and Nephrology section) to identify original articles on chatbot use in urology published between January 2023 and May 2025. Data were analyzed using the Bibliometrix R package and the Biblioshiny interface. Key metrics included publication trends, citation data, keyword networks, authorship patterns, and international collaboration rates.
Results: A total of 81 original articles met the inclusion criteria. The annual growth rate in publication output was 45.3%, with an average of 10.6 citations per article. Most articles appeared in Science Citation Index Expanded indexed journals. The United States (32.1%) and Türkiye (25.9%) were the most prolific countries. However, international collaboration remained low (23.5%). Urolithiasis, prostate cancer, and urinary incontinence were leading clinical themes. Keyword network analysis identified clusters focused on patient education, decision support, and chatbot performance.
Conclusions: This study offers a foundational understanding of chatbot-related research in urology and highlights the need for enhanced international collaboration, clinical validation, and data integration to fully realize their transformative potential.

Keywords: chatbot, large language models, artificial ıntelligence, urology, bibliometric analysis, ChatGPT

Özet

Amaç: Tüm tıp alanlarında olduğu gibi ürolojide de yapay zekâ destekli sohbet robotlarına olan ilgi giderek artmaktadır. Son çalışmalar, bu teknolojilerin hasta eğitimi, klinik karar destek sistemleri ve tıp eğitimi gibi alanlarda potansiyel roller üstlenebileceğini öne sürse de üroloji alanındaki araştırma eğilimlerini değerlendiren kapsamlı bir bibliyometrik analiz henüz yapılmamıştır. Bu çalışma, ürolojide yapay zekâ destekli sohbet robotlarına yönelik mevcut araştırma eğilimlerini ve bilimsel katkılarını kapsamlı bir biçimde ortaya koymayı amaçlamaktadır.
Gereçler ve Yöntemler: Ürolojide yapay zekâ destekli sohbet robotlarının kullanımıyla ilgili Ocak 2023 ile Mayıs 2025 tarihleri arasında yayımlanmış özgün makaleleri belirlemek amacıyla Web of Science Core Collection (Üroloji ve Nefroloji bölümü) veri tabanı kullanılarak kapsamlı bir bibliyometrik analiz gerçekleştirildi. Veriler, Bibliometrix R paketi ve Biblioshiny arayüzü ile analiz edildi. Yayın eğilimleri, atıf verileri, anahtar kelime ağları, en çok katkı veren yazarlar ve uluslararası iş birliği oranları başlıca incelenen metriklerdi.
Bulgular: Çalışmaya toplam 81 özgün makale dâhil edildi. Bu alandaki makalelerdeki yıllık yayın artış oranı %45,3 olarak saptandı. Makale başına ortalama 10,6 atıf yapılmış olduğu görüldü. Makalelerin çoğunun Science Citation Index Expanded indeksli dergilerde yayımlandığı görüldü. Amerika Birleşik Devletleri (%32,1) ve Türkiye (%25,9) en üretken ülkelerdi. Uluslararası iş birliği oranının düşük olduğu gözlendi (%23,5). Üriner sistem taş hastalığı, prostat kanseri ve üriner inkontinans en sık çalışılan klinik temalar arasındaydı. Anahtar kelime ağı analizi, hasta eğitimi, karar destek sistemleri ve yapay zekâ destekli sohbet robotlarının performansı odaklı kümelenmeler olduğunu ortaya koydu.
Sonuç: Bu çalışma, ürolojide yapay zekâ destekli sohbet robotlarının kullanımıyla ilgili araştırma eğilimlerine dair temel bir bakış sunmakta ve bu teknolojilerin dönüştürücü potansiyelinin tam olarak ortaya çıkarılabilmesi için uluslararası iş birliğinin güçlendirilmesi, klinik doğrulama ve veri entegrasyonu gereksinimlerini vurgulamaktadır.

Anahtar kelimeler: sohbet robotları, büyük dil modelleri, yapay zeka, üroloji, bibliyometrik analiz, ChatGPT

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Introduction

In recent years, rapid advances in artificial intelligence (AI) technologies, particularly large language models (LLMs), have transformed the landscape of information processing and decision making across various fields, including healthcare [1]. Since its release, the first globally recognized LLM-based chatbot, ChatGPT, developed by OpenAI in November 2022, has garnered millions of users [2]. Subsequently, several other chatbots have been introduced, including Copilot (formerly Bing Chat, developed by Microsoft in February 2023), Claude (developed by Anthropic in March 2023), and Gemini (formerly Bard, developed by Google in December 2023). These chatbots have demonstrated a remarkable capability to understand and generate human-like texts across diverse domains. Recent studies have shown that chatbots perform exceptionally well in comprehending medical concepts [3].

In the field of urology, chatbot applications remain relatively nascent but are rapidly gaining attention. Emerging research suggests that chatbots can assist in patient counseling for various urological conditions, including benign prostatic hyperplasia, urinary incontinence, erectile dysfunction, and prostate cancer [4-6]. For instance, chatbots can be trained to provide interactive explanations about treatment options, potential side effects, or preprocedural preparations for interventions, such as onabotulinum toxin injections, sacral neuromodulation, or robotic radical prostatectomy [7,8]. They may also aid in interpreting laboratory or imaging results, guiding patients on medication adherence or follow-up schedules, and supporting lifestyle interventions for recurrent stone disease or lower urinary tract symptoms (LUTS) [9,10]. Additionally, from a professional education perspective, chatbots are being explored as tools for medical students and urology residents, including guideline-based content and clinical case simulations [11]. Recent investigations have also assessed whether chatbot responses align with clinical practice guidelines, such as those issued by the European Association of Urology [12].

Bibliometrics, a snapshot of scholarly literature within a defined period, offers a quantitative method for analyzing scientific output and research trends. This strategy allows scholars to uncover prominent authors, high-impact journals, notable institutions, and emerging research themes by analyzing indicators, such as publication volume, citation trends, and co-authorship patterns [13].

Despite growing interest in this subject, no comprehensive assessment has yet been conducted on chatbot-related scientific output in the field of urology. Our study represents the first bibliometric analysis specifically focused on this emerging area. Understanding the development of this interdisciplinary field, situated at the intersection of urology, artificial intelligence, and digital health, is essential to guide future research directions and facilitate clinical integration.

Material and Methods

For this research, the Urology and Nephrology section of the Web of Science (WoS) Core Collection was chosen as the principal data source due to its broad scope and established credibility as a trusted citation index in academic research. This section was specifically preferred because it includes the majority of the leading journals in the field of urology. Additionally, WoS offers robust tools for bibliometric visualization, citation tracking, and trend analysis, making it particularly well suited for examining the evolving research landscape in this domain.

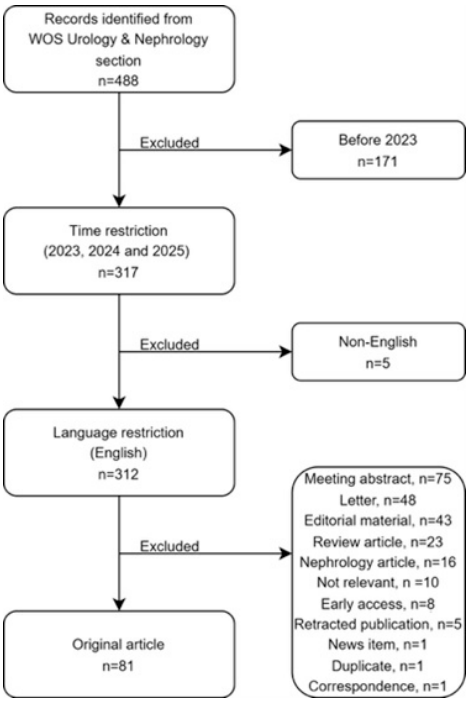

Figure 1. Flowchart of the study

Data were retrieved in a single session on May 21, 2025, to ensure consistency and eliminate the risk of database updates affecting the analysis. A study selection flowchart outlining the identification process of relevant original articles is presented in **Figure 1**. The search strategy applied was TS = "open AI" OR "ChatGPT" OR "Claude" OR "Gemini" OR "Bard" OR "Copilot" OR "Bing Chat" OR "large language model" OR "LLM" OR "chatbot." This query was designed to capture the most prominent and frequently referenced chatbot platforms in the literature.

Given that the first globally recognized chatbot, ChatGPT, was launched in November 2022 and that the earliest publications on chatbot-related research in urology began appearing in 2023, the inclusion period was set to begin in 2023. Publication dates were determined based on the articles' first online publication (excluding early access status).

The inclusion criteria consisted of original research articles in English that focused specifically on chatbots in the field of urology. After excluding 171 articles published before 2023, five non-English publications, and 231 documents that did not meet the eligibility criteria, 81 original articles were included in the final analysis.

The bibliometric analysis was conducted using the Bibliometrix R package [14]. Additionally, the Biblioshiny web application was employed to provide an interactive graphical user interface within the R environment (version 4.4.3), accessed through the RStudio platform (version 2025.05.0).

According to the decision of the Aydin Adnan Menderes University Non-Interventional Ethics Committee, the study

did not require ethical approval, as it involved no human participants, patient data, personal data, animal experiments, or interventional procedures. All analyses were performed using publicly accessible publication records from the Web of Science Core Collection (WoSCC).

Results

Between January 2023 and May 21, 2025, 81 original articles on this topic were identified in the Urology and Nephrology section of the WoS Core Collection. Supplementary material provides a chronological listing of the included articles related to chatbot research in urology.

Publication Trends

Of the 81 articles reviewed, 70 were indexed in the Science Citation Index Expanded (SCIE), while 11 were listed under the Emerging Sources Citation Index (ESCI). Publication output grew at an annual rate of 45.3%, with each article receiving an average of 10.6 citations.

The earliest chatbot-related research publication in the field of urology was the article titled "ChatGPT Performance on the American Urological Association Self-assessment Study Program and the Potential Influence of Artificial Intelligence in Urologic Training" by Deebel et al., which appeared in Urology in May 2023. Including 14 additional papers published in the same year, the total number of studies for 2023 reached 15. This number increased significantly to 54 in 2024, and by May 21, 2025, 13 more studies had been published (**Figure 2**).

Given the growing interest in this topic and the presence of eight additional original articles currently available as early access (thus excluded from the analysis), it is likely that the number of publications in this field will continue to rise sharply in the near future.

Author Analysis

A total of 559 authors contributed to the included studies. Only one article was single authored, indicating that the vast majority of the research was conducted collaboratively. Furthermore, 23.5% of the publications involved international co-authorship, reflecting a limited level of cross-border collaboration.

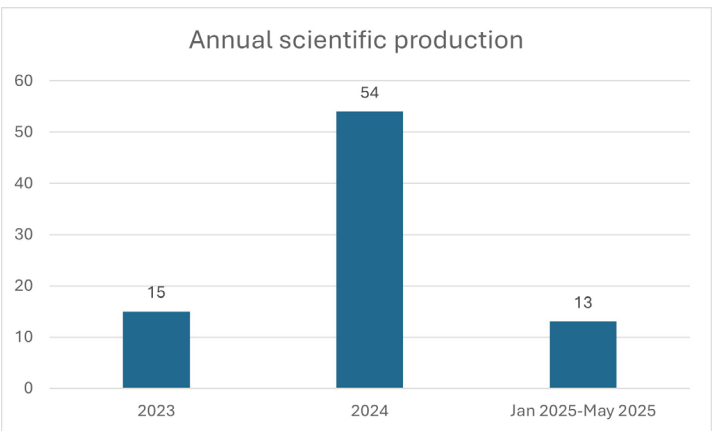

Figure 2. Publication trends for chatbots in the urology field from January 2023 to May 2025

Table 1. Top 10 most productive authors on chatbot-related research in urology

Authors	Articles (N=81), n (%)	Total citations	Local H-index
Caglar U	6 (7.40)	125	5
Ozgor F	6 (7.40)	125	5
Sarilar O	5 (6.2)	87	4
Yildiz O	4 (4.9)	109	4
Ayranci A	4 (4.9)	111	4
Cacciamani G E	3 (3.7)	166	3
Cakir H	3 (3.7)	54	2
Dogan C	3 (3.7)	17	2
Halis A	3 (3.7)	16	1

Table 1 presents the top 10 most productive authors alongside their total citations and local H-index (a combined measure of a researcher's publication output and the number of citations each publication receives) on chatbot-related research. The most prolific contributors were Caglar U. and Ozgor F., each with six publications and 125 total citations, resulting in a local H-index of five. They were followed by Sarilar O. (five articles, 87 citations), Yildiz O. (four articles, 109 citations), and Ayranci A. (four articles, 111 citations), each demonstrating strong scholarly influence. Notably, Cacciamani G. E., with only three publications, accumulated the highest citation count (166) among all listed authors, indicating a high citation-per-article ratio and impactful research contributions.

A collaboration network analysis was performed on 56 authors who contributed to at least two publications. As illustrated in **Figure 3**, the co-authorship network revealed the presence of several distinct clusters, suggesting a fragmented but moderately interconnected research landscape. The largest cluster, represented by brown nodes, demonstrated dense internal connections, indicating a strong pattern of collaboration among its members.

Several other medium-sized clusters also displayed high intragroup collaboration while showing limited connectivity with other clusters. This reflects a structure characterized by localized or institution-specific research efforts with relatively low intergroup interaction. In addition, a number of smaller, isolated clusters were observed, suggesting that some researchers tend to collaborate in small, closed teams rather than engage in broader collaborative networks.

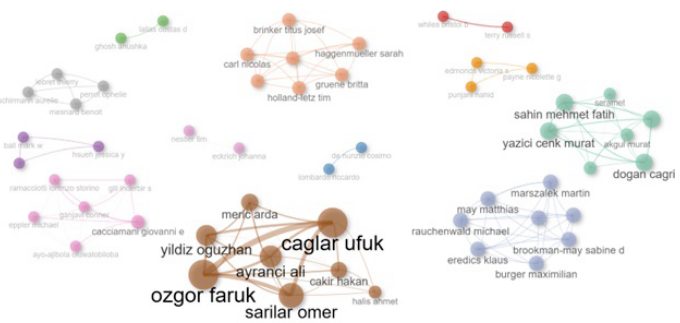

Figure 3. Collaboration network analysis of 56 authors who contributed to at least two publications on this topic

Table 2. Top 10 most productive countries based on corresponding authors' affiliations on chatbot-related research in urology

Country	Articles (N=81), n (%)	SCP	MCP	MCP %
United States	26 (32.1)	21	5	19,2
Türkiye	21 (25.9)	21	0	0
Germany	7 (8.6)	3	4	57,1
China	5 (6.2)	5	0	0
Brazil	3 (3.7)	0	3	100
Canada	3 (3.7)	2	1	33,3
Italy	3 (3.7)	2	1	33,3
Australia	2 (2.5)	2	0	0
France	2 (2.5)	1	1	50
Spain	2 (2.5)	2	0	0

SCP: single country publication, MCP: multiple country publication

Country Analysis

Table 2 lists the top 10 most productive countries in chatbot-related research according to the corresponding author's affiliation. Among 23 countries, the United States led the ranking with 26 articles, representing 32.1% of the total output. This comprised 21 single-country publications (SCPs) and five multiple-country publications (MCPs), resulting in an MCP ratio of 19.2%.

Türkiye ranked second, with 21 articles (25.9%), all of which were SCPs, indicating a strong national contribution but limited international collaboration. Germany followed with seven articles (8.6%), including three SCPs and four MCPs, reflecting a notably high MCP rate of 57.1% and suggesting substantial international engagement. Notably, although Brazil contributed only three articles, they were all classified as MCPs, reflecting a 100% international collaboration rate.

This distribution highlights the prominent role of the United States and Türkiye in driving research on chatbot applications, particularly in the field of urology. Their leadership underscores the two countries' growing academic engagement with AI in clinical contexts.

An international collaboration map was drawn based on the cooperation relationships between countries, with thicker lines indicating more collaboration. Many countries/regions have engaged in relevant cooperation, among which the United States, Germany, Italy, and Brazil have the most frequent collaborations, as shown in **Figure 4**.

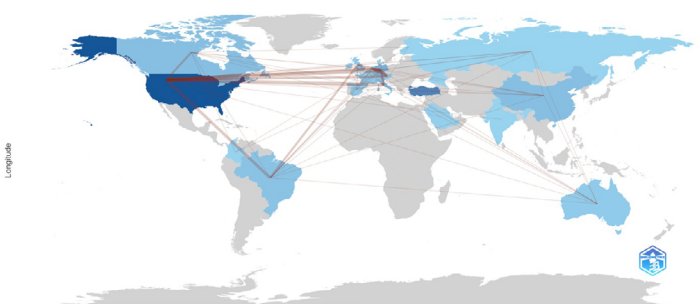

Figure 4. Country collaboration map

Table 3. Top 10 most productive institutions on chatbot related research in urology

Institutions	Articles (N=81), n (%)
Istanbul Haseki Training and Research Hospital (Türkiye)	5 (6.2)
Icahn School Of Medicine at Mount Sinai (United States)	4 (4.9)
Acibadem Hospitals Group (Türkiye)	3 (3.7)
Namik Kemal University (Türkiye)	3 (3.7)
Ruprecht Karls University Heidelberg (Germany)	3 (3.7)
Sapienza University Rome (Italy)	3 (3.7)
State University System of Florida (United States)	3 (3.7)
University of Florida (United States)	3 (3.7)
University of Health Sciences Turkey (Türkiye)	3 (3.7)
University of Munich (Germany)	3 (3.7)

WoS: Web of Science

Analysis by Institutions

Table 3 presents the top 10 most productive institutions in chatbot-related research. Among the 202 institutions identified, Istanbul Haseki Training and Research Hospital ranked first, contributing five articles and accounting for 6.2% of total publications. The Icahn School of Medicine at Mount Sinai followed closely with four articles (4.9%). Notably, both the United States and Türkiye, leading countries in the country-level analysis, also occupy top positions at the institutional level. Eight other institutions shared the third position, each contributing three articles (3.7%).

Source Analysis

The analysis of journal distribution revealed a clear concentration of chatbot-related research in urology in SCIE-indexed journals. Among the 33 unique journals identified in this study, 27 were indexed in the SCIE, while the remaining 6 were indexed in the ESCI.

Among the group of top 10 journals based on publication volume, the World Journal of Urology published the highest number of original articles (n = 14), while the journal Urology stood out with the highest citation count, 161 citations from six articles, indicating strong visibility and influence in the field (**Table 4**).

All but one of the top 10 journals (Urology Practice, indexed in ESCI) were SCIE indexed. The 2023 Journal Impact Factors of the top 10 journals ranged from 0.8 to 5.1. According to the quartile distribution based on the urology and nephrology category in the WoS, three journals were classified as Q1, four as Q2, two as Q3, and one as Q4. These findings indicate that chatbot-related research in urology is being published across a diverse spectrum of journals with varying levels of impact.

Table 4. Top 10 journals on chatbot-related research in urology

Sources	Articles (N=81), n (%)	Total citations	Local H-index	Journal impact factor 2023 (Index)	Journal citation reports quartile (WoS Urology&Nephrology section)
World Journal of Urology	14 (17.2)	82	5	2.8 (SCIE)	2
Journal of Endourology	8 (9.9)	36	4	2.9 (SCIE)	1
Urology	6 (7.4)	161	4	2.1 (SCIE)	2
Urology Practice	6 (7.4)	83	3	0.8 (ESCI)	4
Clinical Genitourinary Cancer	3 (3.7)	20	2	2.3 (SCIE)	2
European Urology Open Science	3 (3.7)	10	2	3.2 (SCIE)	1
International Urology and Nephrology	3 (3.7)	19	2	1.8 (SCIE)	3
Prostate	3 (3.7)	9	2	2.6 (SCIE)	2
Prostate Cancer and Prostatic Diseases	3 (3.7)	99	3	5.1 (SCIE)	1
BMC Urology	2 (2.47)	9	1	1.7 (SCIE)	3

Citation Analysis

Table 5 presents the top 10 most globally cited original articles on chatbot-related research in urology. These articles collectively reflect the growing academic engagement with chatbots in urology. The most cited article, published by Davis et al. in The Journal of Urology (2023), received 69 citations, making it the leading contribution in this field. It was followed by Cocci et al.'s 2024 article in Prostate Cancer and Prostatic Diseases, which garnered 69 citations as well, sharing the top position in terms of citation impact.

Keyword Analysis

Figure 5 displays a word cloud featuring the 50 most frequently used author keywords in original articles on chatbot-related research in urology. As anticipated, the most prominent terms included "artificial intelligence," "ChatGPT," "urology," "large language models," and "chatbot," underscoring the primary themes explored in the analyzed literature. Closely related terms, such as "natural language processing," "Copilot," "Claude," "Bard," and "Gemini," indicate the diversity of chatbots being explored in urology research.

Table 5. Top 10 cited original articles on chatbot-related research in urology

Original articles	Total citations
Davis R, 2023, J Urol	69
Cocci A, 2023, Prostate Cancer Prostatic Dis	69
Coskun B, 2023, Urology	59
Whiles Bb, 2023, Urology	56
Eppler M, 2023, Eur Urol	55
Caglar U, 2023, J Pediatr Urol	44
Eppler Mb, 2023, Urol Pract	42
Deebel Na, 2023, Urology	40
Cakir H, 2023, Int Urol Nephrol	38
Gabriel J, 2023, Int Urol Nephrol	34

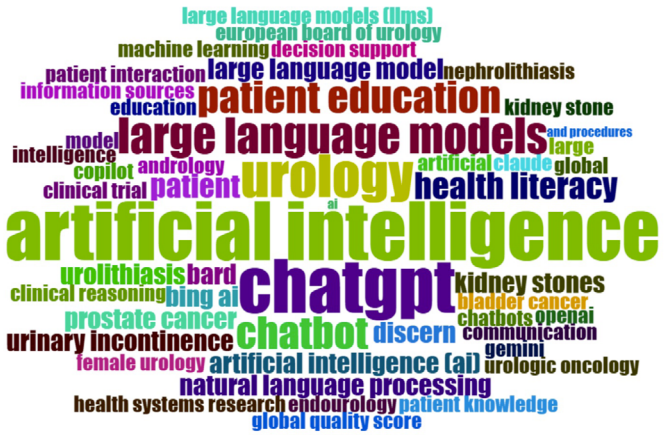

Figure 5. Word cloud of the 50 most prominent keywords

The appearance of clinical keywords such as "prostate cancer," "urinary incontinence," "bladder cancer," and "urolithiasis" suggests that these technologies are being applied across a range of urological subspecialties. In parallel, the frequent use of terms such as "patient education," "health literacy," "communication," and "patient interaction" highlights a strong interest in the use of chatbots to enhance patient engagement and understanding. Furthermore, keywords such as "clinical reasoning," "decision support," and "health systems research" point to an emerging role of chatbots in supporting clinical workflow and healthcare delivery.

Figure 6 illustrates the co-occurrence network of the most prominent authors' keywords generated from the included publications. The terms "artificial intelligence" and "ChatGPT"

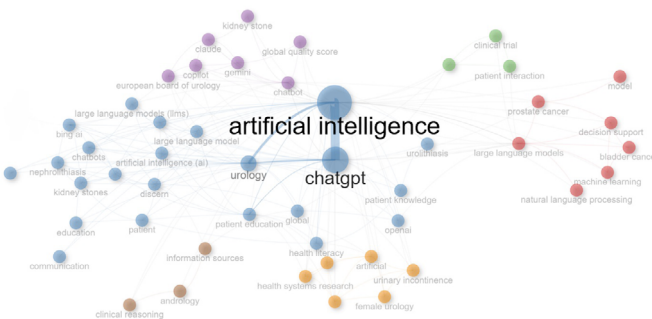

Figure 6. Co-occurrence network of authors' keywords

are centrally positioned and strongly connected, confirming their dominant role as focal points in chatbot-related urology research. Several major thematic clusters emerged in the network. The blue cluster centers around clinical and technological terms such as "patient," "kidney stones," "communication," and "nephrolithiasis," suggesting active research at the intersection of AI technologies and urolithiasis. The orange cluster includes terms like "health literacy," "patient knowledge," "information sources," and "urinary incontinence," emphasizing the patient-centered dimension of chatbot use in functional urology. The green cluster highlights keywords such as "clinical trial," "patient interaction," and "decision support," pointing to the experimental and assistive clinical roles of AI. The red cluster features more technical and disease-specific terms like "prostate cancer," "natural language processing," and "machine learning," suggesting research on specific AI technologies in the context of uro-oncology. The purple cluster is populated by various chatbot platforms, including "Claude," "Gemini," and "Copilot," indicating comparative or multi-platform evaluations.

Discussion

Summary of Key Results

This bibliometric study provides the first snapshot of chatbot-related research in urology. In this study, we comprehensively evaluated the scientific output related to chatbot applications in the field of urology between January 2023 and May 2025. A total of 81 original articles were identified from the Urology and Nephrology section of the WoS Core Collection. The analysis revealed a rapid increase in publication volume, with a 45.3% annual growth rate. Most studies were published in journals indexed in the SCIE, spanning a broad range of impact levels.

The United States and Türkiye emerged as the leading contributors, accounting for nearly 60% of all publications. Notably, institutions such as the Istanbul Haseki Training and Research Hospital (Türkiye) and the Icahn School of Medicine at Mount Sinai (United States) played pivotal roles in driving research output. While countries such as the United States, Germany, Italy, and Brazil exhibited strong international collaboration networks, the overall rate of cross-border co-authorship remained limited to 23.5%.

Keyword and co-occurrence network analyses highlighted that chatbot research in urology centers on both technological development and clinical application. While common terms pointed to the core technologies and tools used, cluster analyses emphasized subspecialty applications, including urolithiasis, uro-oncology, andrology, and functional urology.

Citation analysis showed that the most highly cited articles were generally among the first publications addressing chatbot use in the field of urology. Their high citation counts in such a limited timeframe are unsurprising, as these foundational studies drew attention to a novel and rapidly evolving subject.

Study Implications

The analysis revealed a rapid increase in publication volume, with a 45.3% annual growth rate. This substantial growth highlights the dynamic evolution of AI applications in urology, indicating a shift from experimental concepts to practical clinical tools. Supporting this trend, a global survey involving 456 urologists reported that nearly half of the participants already use LLMs in academic practice [15].

As evidenced by the included studies, numerous investigations involving chatbots have been conducted across various urological subspecialties, including uro-oncology [16], pediatric urology [5], andrology [17], urololithiasis [18], male LUTS [19], and female urology [20]. This diversity, also reflected in the keyword analysis, suggests that chatbot applications powered by LLMs hold promise for implementation across the full spectrum of urological practice.

The prominence of patient education and health literacy themes in the keyword analysis underscores a fundamental shift toward patient-centered care facilitated by AI technologies. Chatbots offer unprecedented opportunities to provide personalized, accessible, and consistent information to patients with urological diseases [21]. However, the successful implementation of these tools requires careful consideration of patient safety, data privacy, and the maintenance of the physician–patient relationship [22].

Limited international collaboration underscores the need for a more robust and globally integrated research agenda in this emerging field. Establishing international research networks could accelerate knowledge exchange and facilitate cross-border studies, which are essential for standardizing chatbot development and implementation in urological practice.

The diversity of chatbot platforms identified in this analysis highlights both opportunities and challenges for clinical integration. While this variety offers flexibility in selecting appropriate tools for specific applications, it also creates fragmentation that may hinder standardization efforts.

Clinical and Ethical Considerations

The reliability of AI chatbots as clinical decision-support tools remains uncertain. Several independent evaluations have shown that although large language models can produce medically coherent answers, they frequently generate inaccurate statements or "hallucinations," which limits their suitability for unsupervised clinical use. Gilson et al. demonstrated that ChatGPT's performance on medical examination questions was inconsistent and often lacked source transparency [23]. Huh similarly reported that ChatGPT provided partially incorrect or unverifiable responses in medical education settings, despite appearing confident and fluent [24]. Beyond accuracy, recent analyses of advanced models such as Med-PaLM have shown improved but still imperfect clinical reasoning, reinforcing that LLMs are not yet reliable for autonomous decision-making [25].

Ethically, the absence of verifiable citations, potential embedded biases, and unclear accountability frameworks pose challenges for integrating chatbots into patient pathways. Experts emphasize that AI should function strictly as an adjunct, supporting but never replacing clinician judgment, until robust regulatory, validation, and monitoring systems are established [26].

Future Research Priorities

Beyond the identified need for enhanced international collaboration, future research should prioritize prospective clinical trials comparing chatbot-assisted versus traditional care pathways, with a focus on patient-centered outcomes, such as satisfaction, adherence to treatment recommendations, and clinical efficacy.

Multicenter validation studies across diverse patient populations are essential to ensure the generalizability and equity of chatbot applications. Additionally, comprehensive health economic evaluations should be conducted, incorporating implementation costs, training demands, and long-term sustainability metrics. To support safe and effective integration into healthcare systems, regulatory framework development in collaboration with medical licensing authorities and AI safety organizations is also critically needed.

Despite the valuable insights provided, this bibliometric analysis has several limitations. First, the study was restricted to publications indexed in the Urology and Nephrology section of the WoS Core Collection. Consequently, relevant studies published in other sections of WoS or indexed in other databases, such as Scopus, PubMed, or Embase, may have been overlooked, potentially leading to the omission of important contributions to the field. This limitation may have affected the comprehensiveness of the findings and the generalizability of the observed trends.

Second, although citation-based metrics are valuable for evaluating research impact, they may not accurately capture the practical relevance or scientific rigor of the studies. Frequently cited articles may owe their impact to novelty or timing rather than methodological rigor or clinical relevance.

Finally, the rapid pace of advances in LLM-based chatbots poses a challenge to the longevity of bibliometric findings as research trends and technological developments quickly evolve.

Conclusions

This study offers a foundational understanding of the current landscape of chatbot-related research in urology. It highlights not only the rapid growth and diverse thematic focus of this emerging field but also the gaps in international collaboration. As conversational AI technologies continue to evolve, future research should prioritize cross-institutional partnerships, deeper clinical evaluations, and broader database integration to enhance the scope and impact of scholarship in this area. These efforts will be essential to the full realization of the potential of LLM-based chatbots in transforming urological care and education.

Ethics Committee Approval: According to the decision of the Aydin Adnan Menderes University Non-Interventional Ethics Committee, the study did not require ethical approval, as it involved no human participants, patient data, personal data, animal experiments, or interventional procedures. All analyses were performed using publicly accessible publication records from the Web of Science Core Collection (WoSCC).

Informed Consent: An informed consent was obtained from all the patients.

Publication: The results of the study were not published in full or in part in form of abstracts.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Any contribution was not made by any individual not listed as an author. Concept – Ç.Ö.; Design – Ç.Ö., M.G.; Supervision – E.A.; Resources – Ç.Ö., M.G.; Materials – Ç.Ö.; Data Collection and/or Processing – Ç.Ö.; Analysis and/or Interpretation – Ç.Ö.; Literature Search – Ç.Ö., M.G.; Writing Manuscript – Ç.Ö., E.A.; Critical Review – E.A.

Conflict of Interest: The authors declare that they have no conflicts of interest.

Financial Disclosure: The authors declare that this study received no financial support.

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Original Article – Reconstructive Urology
Grand J Urol 2026;6(1):21-6
DOI: 10.5505/GJU.2026.83584

Staged Bulbar Urethroplasty Using Bilateral Perineal Skin Flaps as the Urethral Plate

Üretral Yatak Olarak Bilateral Perineal Deri Fleplerinin Kullanıldığı Aşamalı Bulber Üretroplasti

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Abstract

Objective: To assess outcomes of staged bulbar urethroplasty using bilateral perineal skin flaps as urethral plate substitutes in patients with obliterative or nearly obliterative bulbar urethral strictures.
Materials and Methods: A retrospective analysis was conducted on 19 male patients with severe bulbar urethral strictures who underwent two-stage urethroplasty using scrotal or penile fasciocutaneous flaps. Inclusion criteria included urethral mucosa widths less than 3 mm and stricture length exceeding 3 cm. Initially, perineal skin flaps reconstructed the urethral plate. Six months later, a tubularized neourethra was created using scrotal or penile flaps. Patients were evaluated preoperatively and at 1 month and 6 months postoperatively using uroflowmetry and International Prostate Symptom Score (IPSS).
Results: Patient ages ranged from 27 to 76 years, with a median of 60. The median stricture length was 4.6 cm. For those with cystostomy, median IPSS at six months post-surgery was 5 (range: 0-8). Postoperative Qmax values at first (Qmax-1) and sixth months (Qmax-6) were 22 ml/s (range: 14–26 ml/s) and 21 ml/s (range: 14–29 ml/s). In patients with urinary difficulties, the maximum urinary flow rate (Qmax) improved from 4.6 to 20 ml/s post-surgery ($p = 0.0001$), with IPSS reduction from 23 to 4 ($p = 0.005$). Complications were minimal, with no infections, fistulas, or penile deformities. Two patients developed circular strictures requiring internal urethrotomy, and three experienced terminal dribbling.
Conclusion: Staged urethroplasty using bilateral perineal skin flaps is viable and effective for complex bulbar urethral strictures. This method shows favorable functional and cosmetic outcomes with low complications, particularly where single-stage repair is unfeasible.

Keywords: bulbar urethral strictures, staged urethroplasty, perineal skin flaps

Özet

Amaç: Obliteratif veya obliterasyona yakın bulber üretral darlığı olan hastalarda, üretral yatak yerine bilateral perineal deri flepleri kullanılarak yapılan aşamalı bulber üretroplasti sonuçlarını değerlendirmek.
Gereçler ve Yöntemler: Şiddetli bulber üretral darlığı bulunan 19 erkek hasta üzerinde retrospektif analiz yapıldı. Hastalara iki aşamalı üretroplasti uygulandı. Dahil edilme kriterleri üretral mukozanın < 3 mm genişliğe sahip olması ve darlık uzunluğunun > 3 cm olmasıydı. İlk aşamada perineal deri flepleri ile üretral yatak rekonstrükte edildi. Altı ay sonra skrotal veya penil flepler kullanılarak tübülerize neouretra oluşturuldu. Hastalar preoperatif dönemde ve postoperatif 1. ve 6. aylarda üroflowmetri ve Uluslararası Prostat Semptom Skoru (IPSS) ile değerlendirildi.
Bulgular: Hasta yaşları 27–76 yıl arasında olup medyan yaş 60 idi. Medyan darlık uzunluğu 4,6 cm olarak bulundu. Sistostomisi olan hastalarda, cerrahi sonrası 6. ayda medyan IPSS 5 (0–8 aralığında) idi. Postoperatif maksimum idrar akım hızları (Qmax) 1. ayda 22 ml/sn (14–26 ml/sn aralığında), 6. ayda ise 21 ml/sn (14–29 ml/sn aralığında) idi. İşeme güçlüğü olan hastalarda Qmax, cerrahi sonrası 4,6 ml/sn'den 20 ml/sn'ye yükseldi ($p = 0,0001$); IPSS ise 23'ten 4'e düştü ($p = 0,005$). Komplikasyonlar minimaldi; enfeksiyon, fistül veya penil deformite görülmedi. İki hastada internal üretrotomi gerektiren dairesel darlık gelişti, üç hastada ise terminal damlama gözlendi.
Sonuç: Bilateral perineal deri flepleri kullanılarak yapılan aşamalı üretroplasti, kompleks bulber üretral darlıkların tedavisinde uygulanabilir ve etkili bir yöntemdir. Tek aşamalı onarımın mümkün olmadığı durumlarda, düşük komplikasyon oranı ile birlikte fonksiyonel ve kozmetik açıdan yüz güldürücü sonuçlar sağlamaktadır.

Anahtar kelimeler: bulber üretral darlık, aşamalı üretroplasti, perineal deri flepleri

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Introduction

Urethral stricture disease (USD) is a common and complex condition characterized by narrowing of the urethral lumen due to scar tissue formation following urethral injury. The etiology of USD includes external trauma, genitourinary infections, inflammatory dermatological conditions, pelvic radiotherapy, and iatrogenic factors such as urethral instrumentation and endoscopic surgery [1,2]. Although USD can occur in any segment of the male urethra, the bulbar (43%) and penile (37%) segments are most frequently affected [3].

The management of bulbar urethral strictures remains a subject of debate, primarily due to the heterogeneous characteristics of the strictures and variations in surgeon preference. There is no universally accepted optimal procedure for all patients with bulbar urethral stricture. The appropriate repair strategy should be selected based on stricture length, urethral lumen width, the degree of spongiofibrosis, and the underlying etiology [4,5]. Excision and primary anastomosis (EPA) tension-free is considered the most effective surgical option for short bulbar urethral strictures measuring < 2 cm [6]. For strictures > 2 cm in length, substitution urethroplasty using grafts or flaps are required.

Substitution urethroplasty can be performed using either single-stage or staged procedures [7]. Single-stage repair is generally appropriate for simple strictures, whereas staged procedures may be necessary for more complex disease [8]. Fuchs et al. reported a preference for single-stage repair in most cases, with only 30% of patients requiring staged reconstruction [9]. Although the frequency of staged procedures has decreased substantially, they remain an important option in urethral reconstructive surgery. Several critical factors must be considered when deciding between a single-stage and staged approach, including the condition of the urethral plate, the extent of spongiofibrosis, the length of the harvested graft, chordee formation, and the suitability of the urethral graft bed [6].

The precise definition of severe bulbar urethral stricture remains a topic of discussion, as highlighted in the most recent EAU guidelines [10]. Palminteri et al. suggested that a urethral plate measuring less than 3 mm should be classified as a severe stricture, and that severe urethral strictures encompass high-grade, nearly obliterative, and obliterative types [11]. Hoy et al. also emphasized that two-stage repair is necessary in cases of lichen sclerosus, a history of multiple failed hypospadias repairs, or the presence of an obliterated or nearly obliterated urethral lumen [12]. In this study, we report our experience with staged repair using scrotal or penile skin flap urethroplasty in patients with severe bulbar urethral stricture.

Materials and Methods

In this retrospective study, 19 patients diagnosed with bulbar urethral stricture who underwent two-stage urethroplasty using scrotal or penile skin flaps were included. In patients without a suprapubic cystostomy, voiding function was assessed using the International Prostate Symptom Score (IPSS), uroflowmetry (UF), maximum urine flow rate (Qmax), and postvoid residual (PVR) urine volume. Retrograde urethrography (RUG) was performed in all patients to determine the location and length of the urethral stricture. In patients with a suprapubic cystostomy, antegrade cystography with intravesical contrast instillation was additionally performed to more accurately delineate the proximal extent of the stricture. A meticulous physical examination of the oral, genital, perineal, and rectal regions was conducted in all patients.

Buccal mucosal graft (BMG) urethroplasty was offered as the first-line treatment option. Similarly, in patients with an endoscopic appearance suggestive of lichen sclerosus (LS) or in the presence of panurethral stricture, BMG was recommended. In contrast, patients with poor oral hygiene, those who declined BMG, those in whom the urethral plate was considered inadequate to support graft vascularization, or those with a history of failed prior urethroplasty were offered skin flap urethroplasty instead. Patients with a hairless perineum or with only minimal perineal hair that would not interfere with the operative field were considered suitable candidates for skin flap urethroplasty. In patients with excessive perineal hair, perineal/scrotal hair removal was performed by electrocauterization during the first stage, whereas in those unsuitable for cauterization it was achieved by laser epilation prior to the second-stage. Laboratory evaluation included urinalysis, urine culture, and serum biochemical analyses, including renal function tests. All patients were thoroughly informed about the surgical procedure, and written informed consent was obtained prior to surgery. The study protocol was approved by the Clinical Research Ethics Committee of Gazi University School of Medicine (No: 2025 - 1027- date: May 27, 2025).

Surgical Technique

All surgical procedures were performed by a single surgeon. In the first stage, under general anesthesia, patients were placed in the dorsal lithotomy position to access the bulbar urethra. After appropriate positioning, the lower abdomen, genital region, and perineum were scrubbed with povidone-iodine for five minutes. Initially, urethroscopy was performed to visualize the strictured segment of the urethra and, when feasible, to advance a guidewire into the bladder. The bulbar urethra was then

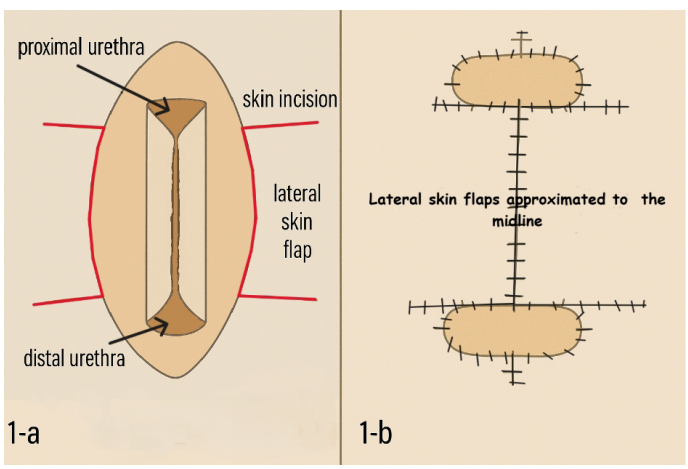

Figure 1. Perineal midline incision to exposure of obliterative bulbar urethra (a) Exposure of the urethral plate and design of the skin incision (b) Each lateral skin flap was approximated in the midline to reconstruct the urethral plate

exposed through a midline perineal incision, and the strictured segment was identified. The narrowed urethral segment was incised proximally and distally until healthy urethral tissue was reached. The criteria for choosing a staged urethroplasty were a urethral mucosal width of less than 3 mm at the stricture site and a stricture length exceeding 30 mm.

Following placement of an 18 Fr urethral catheter, bilateral perineal skin flaps were mobilized and approximated, and the edges of the urethral mucosa were sutured to the perineal skin flaps using 4-0 polyglactin sutures. In cases of obliterative bulbar urethral stricture, the fibrotic urethral segment was excised, the bilateral skin flaps were approximated and sutured in the central perineum with 4-0 polyglactin sutures, and then anastomosed to the proximal and distal urethral ends (**Figures 1 and 2**). The urethral catheter was removed on the fifth postoperative day, during which no complications were observed. Patients were able to void comfortably in the sitting position through the perineostomy.

Six months after the initial procedure, the second-stage of the reconstruction was performed. In this stage, depending on the length of the urethral defect in the perineum, either a penile or a scrotal fasciocutaneous flap was prepared. For the scrotal fasciocutaneous flap, a hairless midline area was preferred. The width of the fasciocutaneous flap ranged from 15 to 20 mm, according to the width of the existing urethral plate. The flap was transferred to the anastomotic site through a tunnel created in the midline of the scrotum, without torsion or excessive tension on the pedicle. Under 2.5X magnification, the flap was anastomosed to the urethral plate over an 18 F urethral Foley catheter using 5-0 polydioxanone sutures, ensuring a tension-free repair. The anastomotic area was then covered with surrounding soft tissue. After meticulous hemostasis to prevent postoperative hematoma, the skin and subcutaneous tissues were closed in layers, and a compression dressing was applied to the perineal region. No suprapubic catheter or perineal drain was used. Patients received parenteral third-generation cephalosporins for five days, followed by oral ciprofloxacin 500 mg twice daily until catheter removal. The urethral Foley catheter was left in place for 21 days.

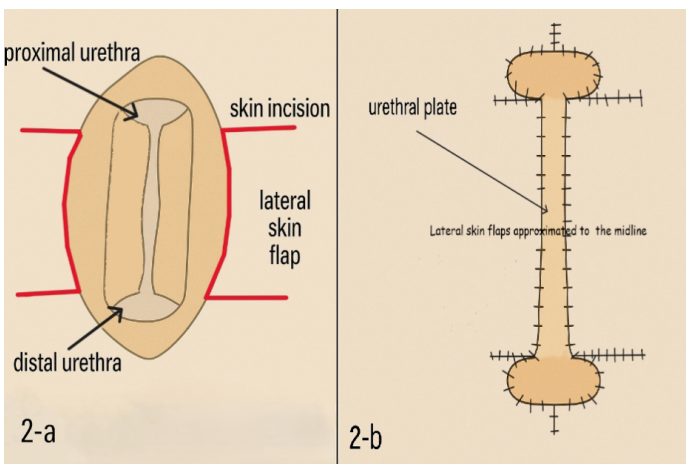

Figure 2. Perineal midline incision to exposure of nearly obliterative bulbar urethra (a) Exposure of the urethral plate and design of the skin incision (b) Each lateral skin flap was approximated in the midline to reconstruct the urethral plate

Follow-up

Patients were evaluated at the first and sixth months after the reconstruction. In patients without a suprapubic cystostomy, urine flow was assessed by UF preoperatively, at the first postoperative month, and at the sixth postoperative month. In this group, the IPSS questionnaire was administered preoperatively and at the sixth postoperative month. In patients with a suprapubic cystostomy, uroflowmetry was performed at the first and sixth postoperative months, and the IPSS questionnaire was administered at the sixth postoperative month. Urethroscopy was performed in patients who developed voiding difficulties or whose Qmax was less than 10 mL/s. After the 6-month evaluation, patients were instructed to return if they experienced any subsequent voiding difficulties.

Statistical Analysis

Descriptive and inferential statistical methods were used for the analysis. Quantitative variables are presented as median and range, whereas qualitative variables are expressed as frequencies and percentages. The Mann–Whitney U test was used for comparisons between independent groups. The Wilcoxon signed-rank test was applied to compare paired variables within groups, and the Friedman test was used for comparisons of repeated measures with three time points. A p-value of < 0.05 was considered statistically significant.

Results

The median age of the patients was 60 years (27–76). The etiology of the stricture, number of prior endoscopic interventions, presence of complete obstruction on RUG, presence of suprapubic cystostomy, and stricture length are summarized in **Table 1**. A scrotal fasciocutaneous flap was used in 8 patients, whereas a penile fasciocutaneous flap was used in 11 patients. The median follow-up duration after the second-stage repair was 30 months (12–60).

The participants were divided into two cohorts: Cohort 1 consisted of patients with a suprapubic cystostomy, whereas

Table 1. Demographic and clinical characteristics of the patients

Age (year) (median, min-max)	**60 (27-76)**
Etiology	
Traumatic catheterization (n, %)	6 (31,5%)
Endoscopic procedures (n, %)	5 (26,3%)
Straddle trauma (n, %)	8 (42,2%)
Internal urethrotomies ≥3 (n, %)	11 (57,8%)
Suprapubic cystostomy (n, %)	9 (47,3%)
Complete obstruction on RUG (n, %)	8 (42,2%)
Stricture length (cm) (median, min-max)	5 (3,5-7)

Cohort 2 included patients without a suprapubic cystostomy. In Cohort 1, the median age was 55 years (27–72), and the median stricture length was 5.7 cm (3.5–7). Preoperative Qmax and IPSS values were not available for this cohort. Postoperative Qmax values at the first (Qmax-1) and sixth months (Qmax-6) were 22 mL/s (14–26) and 21 mL/s (14–29), respectively, with no statistically significant difference between these two time points ($p = 0.521$). The median IPSS at 6 months postoperatively was 5 (0–8). In Cohort 2, the median age was 63 years (46–76), and the median stricture length was 4.4 cm (3.5–5). The preoperative Qmax (Qmax-0), and postoperative Qmax values at the first (Qmax-1) and sixth months (Qmax-6) were 4.6 mL/s (3–8), 20 mL/s (14–25), and 16 mL/s (14–21), respectively. A statistically significant difference was observed among these three time points $p < 0.001$, primarily attributable to the low preoperative Qmax-0 values. The postoperative Qmax values at the first and sixth months were approximately fourfold higher than the preoperative values. The median preoperative and 6-month postoperative IPSS values were 23 (18–25) and 4 (3–5), respectively, with a statistically significant difference ($p = 0.005$). There were no statistically significant differences between the two cohorts in terms of age, stricture length, or postoperative Qmax and IPSS values (all $p > 0.05$) (**Table 2**).

No early postoperative complications such as wound dehiscence, perineal hematoma, urinary tract infection, or wound infection were observed. In addition, no urethrocutaneous fistula, penile rotation, or penile curvature occurred. Within the first postoperative week, penile edema was documented in 2 patients and scrotal edema in 3 patients; all cases resolved spontaneously within 1 week. Two patients (10.5%), one from cohort 1 and one from cohort 2, underwent laser-assisted internal urethrotomy 12 months after the repair because of persistent voiding difficulties despite a Qmax of 14 mL/s. In these patients, circular strictures were identified at the proximal anastomotic site. No recurrent stricture was observed after internal urethrotomy. Three patients (15.7%) reported terminal dribbling. In cohort 1, one patient (5%) developed a saccular dilatation in the flap segment, which did not require further intervention. No additional complications were recorded. Overall, the patients reported satisfaction with the cosmetic appearance of the penis.

Table 2. Comparison of preoperative and postoperative outcomes

	SPC (n=9)	Non-SPC (n=10)	P value
Age (year) (median, min-max)	55 (27-72)	63 (46-76)	0,25
Stricture length (cm) (median, min-max)	5,7 (3,5-7)	4,4 (3,5-5)	0,16
Preoperative Qmax (ml/s)	NA	4,6 (3-8)	
Postoperative Qmax-1 months (ml/s)	22 (14-26)	20 (14-25)	0,652
Postoperative Qmax-6 months (ml/s)	21 (14-29)	16 (14-21)	0,460
Preoperative IPSS	NA	23 (18-25)	
Postoperative IPSS-6 months	5 (0-8)	4 (3-5)	

SPC: suprapubic cystostomy; IPSS: international prostate symptom score; Qmax: maximum urine flow rate

Discussion

There is still no consensus regarding the optimal technique, particularly with respect to whether a graft or flap should be used and whether the repair should be performed as a primary or staged procedure. Although single-stage repairs are generally effective in the treatment of most bulbar urethral strictures, staged repair may be required in certain cases. In our practice, the criteria for perineal urethrostomy were defined as a urethral mucosal width of less than 3 mm and a stricture length exceeding 30 mm. Current EAU guidelines recommend that staged procedures be considered when the urethral plate is inadequate for single-stage surgery [10]. A urethral lumen wider than 6 Fr has been defined as the criterion for an acceptable urethral plate [13], and Palminteri et al. similarly reported that a urethral mucosal width of less than 3 mm indicates an inadequate urethral plate [11]. Preoperative RUG corroborated these intraoperative findings.

Urethral mucosal width is a critical parameter in determining the suitability of staged urethroplasty. Penile and scrotal island flap urethroplasty provides well-vascularized, pliable, and reliable tissue for urethral substitution. Penile and scrotal skin flaps can be easily transferred to the site of bulbar urethral stricture for reconstruction. The cosmetic appearance of the penis following wound healing remained satisfactory. Our study suggests that staged urethroplasty should be considered in patients with obliterative or nearly obliterative bulbar urethral strictures. In our approach, bilateral perineal skin flaps were used instead of buccal or dermal skin grafts in the first stage to create a healthy urethral plate. At 12 months after the repair, only two patients required a single internal urethrotomy session. Based on these outcomes, this staged technique was considered successful. Furr et al. reported a long-term success rate of 93% with their two-stage urethroplasty technique using BMG [14]. In our study, the success rate was 89.5%.

In the current literature, the indications for staged urethroplasty include an obliterative or nearly obliterative segment in the bulbar urethra, lichen sclerosus, and previously failed hypospadias repairs [7,11,12,15]. In the management of urethral strictures associated with lichen sclerosus (LS), the use of genital skin-based flaps or grafts is not recommended [16]. EPA is not an appropriate repair method for strictures longer than 2–3 cm, and single-stage substitution urethroplasty may not be feasible when the urethral plate is insufficiently wide. In such cases, as previously described, perineal urethrostomy is performed in the first stage. After healing of the urethral plate, urethral reconstruction with a flap or graft procedure is performed in the second-stage. Various grafts have been described, including penile, scrotal, and extragenital skin, bladder mucosa, colonic mucosa, and buccal mucosa. Initially, skin grafts or flaps were used for substitution bulbar urethroplasty [4,17,18]. Grafts are easier to harvest, are associated with lower donor-site morbidity, and are quicker to apply [12]. Most surgeons prefer

grafts for urethral reconstruction because flap preparation is technically more demanding and complex [19]. However, the quality of the graft bed is crucial for graft survival, as it must be suitable for imbibition and inosculation [20]. In addition, Andrich et al. reported that grafts tend to shrink over time, leading to deterioration of the long-term outcomes of urethral reconstruction using grafts [15]. In a systematic review, Barratt et al. investigated the optimal technique for graft placement in single-stage repair of bulbar urethral strictures and reported that the outcomes of bulbar free-graft urethroplasty tended to worsen over time [21]. For these reasons, we preferred to use penile and scrotal skin flaps for the repair of severe bulbar urethral strictures.

After confirmation that the graft has healed without complications, an interval of at least four to six months is recommended before proceeding with tubularization of the urethra [4,7,22]. We prefer to wait six months before performing the second-stage repair. Although sacculation or pseudodiverticulum formation has been reported to occur more frequently with pedicled flaps than with grafts, due to the tendency to oversize the flap [6], only one patient in our cohort developed saccular urethral dilatation. In certain clinical situations, such as oral leukoplakia, poor oral hygiene combined with heavy tobacco smoking or chewing, prior irradiation, or previous buccal mucosa graft (BMG) harvesting, BMG is either not feasible or not advisable. A urologist proficient in safely harvesting different types of grafts has a clear advantage in urethral reconstruction [23].

Following perineostomy or the first stage of staged urethroplasty, the catheter may be removed after three to five days without the need for urethrography [24,25]. After urethroplasty, it is generally recommended that an indwelling catheter be maintained for 2–3 weeks [26,27]. In our study, the catheter was removed on the fifth day after the first stage and in the third week after the second-stage.

This study has several limitations that should be acknowledged. First, its retrospective design may have introduced selection and information bias, potentially affecting the internal validity of the findings. Second, the absence of a control group treated with graft-based or single-stage urethroplasty limits the ability to make direct comparisons regarding the relative efficacy and safety of different reconstructive approaches. Third, the small sample size further restricts the generalizability of the results to broader patient populations. In addition, although postoperative outcomes were assessed using standard measures such as uroflowmetry and the IPSS, the study did not employ a urethra-specific, validated patient-reported outcome instrument, such as the Urethral Stricture Surgery Patient-Reported Outcome Measure (USS-PROM), which is specifically designed to capture both voiding function and health-related quality of life and could have provided a more comprehensive evaluation of treatment outcomes.

Conclusions

In conclusion, this study provides important insight into the outcomes of staged repair using scrotal or penile skin flaps for the treatment of bulbar urethral strictures. In patients with obliterative or nearly obliterative bulbar urethral strictures, staged urethroplasty using fasciocutaneous skin flaps should be regarded as a valuable and effective reconstructive option.

Ethics Committee Approval: The study protocol was approved by the Clinical Research Ethics Committee of Gazi University School of Medicine (No: 2025 - 1027- date: May 27, 2025).
Informed Consent: An informed consent was obtained from all the patients.
Publication: The results of the study were not published in full or in part in form of abstracts.
Peer-review: Externally peer-reviewed.
Authorship Contributions: Any contribution was not made by any individual not listed as an author. Concept – A.A., E.C.B., F.P., S.Y.; Design – A.A., M.Y.K.; Supervision – A.A., B.E., F.P., S.Y.; Resources – M.Y.K., E.C.B., B.E., F.P., S.Y.; Materials – M.Y.K., B.E.; Data Collection and/or Processing – M.Y.K., E.C.B., B.E.; Analysis and/or Interpretation – M.Y.K., E.C.B., B.E.; Literature Search – E.C.B., B.E., F.P., S.Y.; Writing Manuscript – A.A., F.P., S.Y.; Critical Review – A.A., F.P., S.Y.
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Risk Factors Predicting the Need for Urgent URS in Patients Undergoing SWL for Proximal Ureteral Stones

Proksimal Üreter Taşı İçin SWL Yapılan Hastalarda Acil URS Gereksinimini Tahmin Eden Risk Faktörleri

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Abstract

Objective: To evaluate the clinical, anatomical, and stone-related factors in patients who underwent shock wave lithotripsy (SWL) for proximal ureteral stones and to identify the risk factors associated with the subsequent need for urgent ureteroscopy (URS).
Materials and Methods: Patients who underwent SWL for proximal ureteral stones were included in the study. Demographic and clinical characteristics, including age, body mass index (BMI), serum creatinine, white blood cell count, hemoglobin, and platelet count, were recorded. Stone characteristics and anatomic factors were determined using parameters obtained from non-contrast lower upper abdomen computed tomography scans: stone density (HU), stone diameter, renal pelvis urine density (HU), perirenal stranding, stone-skin distance, and ureteral wall thickness. Patients who underwent emergency URS were grouped. Logistic regression analysis was used to identify risk factors predicting the need for urgent URS in patients.
Results: Among the study population, 232 patients (83.8%) did not require urgent URS (Group 1), while urgent intervention was necessary in 45 patients (16.2%) (Group 2). Patients in the urgent URS group demonstrated a significantly higher body mass index (26 [24-27] vs. 25 [24-26] kg/m², p = 0.002). Non-contrast CT findings revealed that renal pelvis urine density and stone–skin distance were markedly greater in the URS group (13 [9-36] vs. 8 [6-11] HU, p < 0.001 and 12 [6-16] vs. 9 [7-13] cm, p < 0.001, respectively). Stone density was also higher among patients requiring URS (862 [784-1014] vs. 786 [665-956] HU, p = 0.002). In multivariable analysis, BMI (OR 1.245, 95% CI 1.025–1.512, p = 0.028), stone density (OR 1.003, 95% CI 1.001–1.004, p = 0.002), renal pelvis urine density (OR 1.032, 95% CI 1.009–1.055, p = 0.006), and stone–skin distance (OR 1.654, 95% CI 0.986–1.846, p = 0.004) remained as independent predictors.
Conclusion: BMI, stone density, renal pelvic urine density, and stone–skin distance parameters may serve as useful guidance when considering SWL for patients with proximal ureteral stones. Prospective studies with larger samples are needed to support the findings.

Keywords: SWL, urolithiasis, urgent URS, proximal ureteral stones

Özet

Amaç: Proksimal üreter taşı nedeniyle SWL uygulanan hastalarda klinik, anatomik ve taşla ilişkili faktörleri değerlendirmek ve sonrasında acil URS ihtiyacıyla ilişkili risk faktörlerini belirlemek.
Gereçler ve Yöntemler: Proksimal üreter taşı nedeniyle SWL uygulanan hastalar çalışmaya dahil edildi. Yaş, vücut kitle indeksi, serum kreatinin, beyaz kan hücresi sayısı, hemoglobin ve trombosit sayısı gibi demografik ve klinik özellikler kaydedildi. Taş özellikleri ve anatomik faktörler, kontrastsız alt ve üst karın BT taramalarından elde edilen parametreler kullanılarak belirlendi: taş yoğunluğu (HU), taş çapı, renal pelvis idrar yoğunluğu (HU), perirenal kontaminasyon, taş-deri mesafesi ve üreter duvar kalınlığı. Acil URS uygulanan hastalar gruplandırıldı. Hastalarda acil URS ihtiyacını öngören risk faktörlerini belirlemek için lojistik regresyon analizi kullanıldı.
Bulgular: Çalışma popülasyonunda 232 hasta (%83,8) acil URS'ye (Grup 1) ihtiyaç duymazken, 45 hastada (%16,2) acil müdahale gerekti (Grup 2). Acil URS grubundaki hastalar anlamlı derecede daha yüksek vücut kitle indeksi (26 [24-27] – 25 [24-26] kg/m², p = 0,002) gösterdi. Kontrastsız BT bulguları, renal pelvis idrar yoğunluğunun ve taş-cilt mesafesinin URS grubunda belirgin şekilde daha yüksek olduğunu ortaya koydu (sırasıyla 13 [9-36] – 8 [6-11] HU, p < 0,001 ve 12 [6-16] – 9 [7-13] cm, p < 0,001). Taş dansitesi URS gerektiren hastalarda da daha yüksekti (862 [784-1014] vs. 786 [665-956] HU, p = 0,002). Çok değişkenli analizde, BMI (OR 1,245, %95 CI 1,025–1,512, p = 0,028), taş dansitesi (OR 1,003, %95 CI 1,001–1,004, p = 0,002), renal pelvis idrar dansitesi (OR 1,032, %95 CI 1,009–1,055, p = 0,006) ve taş-cilt mesafesi (OR 1,654, %95 CI 0,986–1,846, p = 0,004) bağımsız öngörücüler olarak kaldı.
Sonuç: VKİ, taş yoğunluğu, renal pelvis idrar dansitesi ve taş-cilt mesafesi parametreleri, proksimal üreter taşı olan hastalarda SWL'yi değerlendirirken faydalı bir rehber olabilir. Bulguları desteklemek için daha geniş örneklemli prospektif çalışmalara ihtiyaç vardır.

Anahtar kelimeler: SWL, ürolitiyazis, acil URS, proksimal üreter taşları

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Introduction

Urolithiasis represents one of the leading causes of morbidity in urological practice, and its incidence has been steadily increasing worldwide [1,2]. Currently, miniaturized ureterorenoscopes represent the preferred approach for ureteral calculi, given their high efficacy and favorable safety profile [3]. In contrast, for proximal ureteral stones <1 cm, shock wave lithotripsy (SWL) is highlighted by the European Association of Urology (EAU) guidelines as a cost-effective, non-invasive modality associated with fewer stent-related symptoms [4]. Despite these advantages, the clinical success of SWL is far from universal and is influenced by multiple factors, including stone size, density, anatomical considerations, and individual patient characteristics.

Reported stone-free rates for proximal ureteral stones treated with SWL vary considerably, generally ranging between 40% and 80% [5,6]. Treatment failure inevitably leads to the need for secondary interventions, most commonly ureteroscopy (URS). The necessity for an additional procedure not only prolongs treatment but also increases healthcare costs, exposes patients to additional anesthesia and surgical risks, and may negatively affect overall patient satisfaction. Therefore, the ability to identify patients at higher risk of SWL failure is of considerable importance in optimizing treatment planning and minimizing unnecessary procedures.

Previous studies have suggested that stone-related variables, such as diameter and attenuation, as well as host-related factors including hydronephrosis, body mass index (BMI), and sex, may influence SWL outcomes [7,8]. However, evidence specifically focusing on proximal ureteral stones remains limited, and consensus on reliable predictors of SWL failure requiring urgent URS has yet to be established.

The aim of this study is to evaluate the clinical, anatomical, and stone-related factors in patients who underwent SWL for proximal ureteral stones and to identify the risk factors associated with the subsequent need for urgent URS. Identifying such parameters may help refine patient selection, improve individualized treatment strategies, and ultimately enhance both clinical outcomes and patient satisfaction.

Material and Methods

Patient Selection

This study was approved by the Erzurum Medical Faculty Local Ethics Committee (approval number: BAEK 2025/10-265). After ethical approval patients treated with SWL for radio-opaque proximal ureteral stones at the Department of Urology, Erzurum City Hospital included in the study. Patients with incomplete medical records, congenital urinary tract anomalies, concomitant renal stones, or stone size greater than 1 cm were excluded from the analysis. Proximal ureter was defined as the segment extending from the ureteropelvic junction to the upper border of the iliac vessels.

Demographic and clinical data were collected, including age, gender, BMI, and comorbidities. Laboratory parameters recorded prior to the procedure were serum creatinine, hemoglobin, white blood cell (WBC) count, platelet count, and urine culture results. Radiological variables obtained from non-contrast computed tomography (NCCT) included stone diameter, Hounsfield unit (HU), renal pelvis urine HU, perirenal stranding, proximal and distal ureteral diameters, stone-skin distance and ureteral wall thickness at the stone level.

After creating the patient sample and collecting related parameters, patients were classified into two separate groups: those who developed an urgent need for URS and those who did not. Urgent URS was applied to patients pain despite medical treatment, fever/sepsis findings, obstruction and increased creatinine, and steinstrasse that refers to the alignment of fragmented calculi within the ureter after SWL.

Disease Management

In accordance with the EAU guidelines, patients with ureteral stones smaller than 1 cm were considered candidates for either SWL or URS. URS was directly indicated in cases of severe renal colic, pyonephrosis, or acute renal failure. In the absence of these factors and in patients without urinary tract infection, SWL was used as the first-line treatment. Each treatment session was performed according to a standardized protocol and consisted of up to 2,000–2,500 shock waves. Shock waves were delivered with a maximum energy setting of approximately 18 kV and a pulse frequency ranging between 1.0 and 1.5 Hz, in accordance with manufacturer specifications (Wolf Piezolith, Germany). Shock waves were targeted under fluoroscopic guidance. Procedures were performed by an experienced registered nurse with more than ten years of training in SWL and were carried out under the supervision of a urology specialist. Analgesia was provided with intravenous paracetamol at a dose of 1 g administered prior to the SWL procedure. Sedation was provided with intravenous midazolam (0.03–0.05 mg/kg) during the SWL procedure. A minimum interval of two weeks was maintained between consecutive SWL sessions.

Patients were followed at two-week intervals with direct urinary system graphy (DUSG). Additional SWL sessions were administered when necessary, up to a maximum of three. One month after the final session, NCCT was performed to evaluate stone-free status. Urgent URS was performed in cases of severe renal colic or pyonephrosis following SWL. During follow-up, patient-reported outcomes such as pain severity, urinary symptoms, and any adverse events were systematically recorded to assess both clinical efficacy and safety. Laboratory parameters, including serum creatinine and urinalysis, were monitored to detect renal impairment or infection. Patient compliance with hydration and analgesic recommendations was also reinforced, and lifestyle advice was provided to minimize stone recurrence. This structured follow-up ensured timely identification of complications and optimization of individualized management strategies.

Statistical Analysis

All statistical evaluations were performed using IBM SPSS 20.0. Categorical data were summarized as frequencies and percentages. The distribution of continuous variables was examined using the Kolmogorov-Smirnov test. In cases where the data showed normal distribution, comparisons between two groups were carried out with the independent samples t-test, while the Mann–Whitney U test was applied for non-normally distributed variables. Relationships between categorical parameters were

Table 1. Comparison of demographic and clinical characteristics of SWL patients according to urgent URS requirement

Parameter (Median [IQR], n (%))	Group 1 (n=232)	Group 2 (n=45)	P value
Age, (years)	44 [33-59]	53 [33-61]	0.174*
BMI, (kg/m2)	25 [24-26]	26 [24-27]	**0.002***
Gender Male Female	 117 (50.4) 115 (49.6)	 20 (44.4) 25 (55.6)	0.462#
Creatinine, (mg/dL)	0.7 [0.6-0.9]	0.7 [0.6-0.9]	0.213*
WBC, ($\times 10^3/\mu L$)	6950 [5640-9280]	6640 [5130-8620]	0.367*
Hemoglobin (g/dl)	13.8 [13.2-14.9]	13.8 [13.4-14.9]	0.622*
Platelet, ($\times 10^3/\mu L$)	298 [247-362]	326 [265-368]	0.102*
Stone diameter,(mm)	7 [4-10]	8 [6-10]	**0.011***
Stone HU	786 [665-956]	862 [784-1014]	**0.002***
Ureter wall thickness,(mm)	2.1 [1.9-2.7]	2.2 [2.0-2.7]	0.454*
Proximal ureteral diameter,(mm)	10 [8-11]	8 [6-11]	0.066*
Distal ureteral diameter,(mm)	6 [5-7]	6 [5-8]	0.852*
Renal pelvis urine HU	8 [6-11]	13 [9-36]	**<0.001***
Stone-skin distance, (cm)	9 [7-13]	12 [6-16]	**<0.001***
Perirenal stranding Yes No	 59 (25.4) 173 (74.6)	 23 (51.1) 22 (48.9)	**0.001#**
Number of SWL sessions	2 [1-3]	1 [1-1]	**<0.001***
Time to urgent URS, (days)	-	1 [1-2]	**-**
Stone free rate	208 (89.6)	37 (91.1)	0.948#

Group 1: SWL none-urgent URS group; Group 2: urgent URS group; HU: Hounsfield unit; BMI: body mass index; *Man-Whitney U test; #Chi-square test

assessed using either the Pearson χ^2 test or Fisher's exact test, depending on suitability. A probability value below 0.05 was accepted as the threshold for statistical significance. Univariable and multivariable binary logistic regressions were applied to identify factors associated with the need for urgent URS.

Results

A total of 277 patients who underwent SWL for proximal ureteral stones were included in the analysis. Among the study population, 232 patients (83.8%) did not require urgent URS (Group 1), while urgent intervention was necessary in 45 patients (16.2%) (Group 2) (**Table 1**).

The median age did not differ significantly between none urgent URS group and urgent URS group (44 [33-59] vs. 53 [33-61] years, p = 0.174). Gender distribution was also comparable across groups (p = 0.462). Patients in the urgent URS group demonstrated a significantly higher body mass index (26 [24-27] vs. 25 [24-26] kg/m², p = 0.002). Laboratory parameters, including serum creatinine, white blood cell count, hemoglobin, and platelet count, were similar between the two groups (p > 0.05 for all) (**Table 1**).

With respect to stone characteristics, the median stone diameter was slightly larger in the URS group (8 [6-10] vs. 7 [4-10] mm, p = 0.011). Stone density was also higher among patients requiring URS (862 [784-1014] vs. 786 [665-956] HU, p = 0.002). Non-contrast CT findings revealed that renal pelvis urine density and stone–skin distance were markedly greater in the URS group (13 [9-36] vs. 8 [6-11] HU, p < 0.001 and 12 [6-16] vs. 9 [7-13] cm, p < 0.001, respectively). Furthermore, perirenal stranding was significantly more frequent in the URS cohort (51.1% vs. 25.4%, p = 0.001). Other CT-derived parameters, including ureteral wall thickness and ureteral diameters, did not differ significantly (**Table 1**).

Univariable logistic regression identified BMI, stone density, renal pelvis urine density, stone–skin distance, and the presence of perirenal stranding as significant predictors of urgent URS requirement after SWL. In multivariable analysis, BMI (OR 1.245, 95% CI 1.025–1.512, p = 0.028), stone density (OR 1.003, 95% CI 1.001–1.004, p = 0.002), renal pelvis urine density (OR 1.032, 95% CI 1.009–1.055, p = 0.006), and stone–skin distance (OR 1.654, 95% CI 0.986–1.846, p = 0.004) remained as independent predictors (**Table 2**).

Receiver operating characteristic (ROC) analysis was performed to further evaluate the discriminative performance of these predictors. The area under the curve (AUC) was 0.640 for BMI (cut-off 24.5 kg/m², sensitivity 66.7%, specificity 46.4; p = 0.003)

Table 2. To predict urgent URS requirement after SWL univariable and multivariable logistic regression analysis performed

	Univariable			Multivariable		
Parameter	**OR**	**95% CI**	**P value**	**OR**	**95% CI**	**P value**
Age (years)	1.017	0.995-1.039	0.137			
Gender	1.272	0.669-2.416	0.463			
BMI (kg/m^2)	1.352	1.125-1.625	**0.001**	1.245	1.025-1.512	**0.028**
Stone diameter (mm)	1.139	0.876-2.284	0.171			
Stone density (HU)	1.003	1.001-1.004	**0.001**	1.003	1.001-1.004	**0.002**
Proksimal ureter diameter (mm)	0.914	0.816-1.025	0.124			
Distal ureter diameter (mm)	0.977	0.809-1.179	0.807			
Renal pelvis urine density (HU)	1.045	1.025-1.065	**<0.001**	1.032	1.009-1.055	**0.006**
Ureter wall thickness (mm) Perirenal stranding	1.295 3.065	0.786-2.133 1.592-5.901	0.310 **0.001**	 1.842	 0.874-3.884	 0.109
Stone-skin distance	1.372	1.112-1.698	**<0.001**	1.654	0.986-1.846	**0.004**
Creatinine value (mg/dL)	0.401	0.087-1.859	0.243			
WBC count (µ/L)	1.032	0.858-1.741	0.312			
Hb level (g/dl)	1.054	0.824-1.348	0.677			
Platelet	1.003	0.999-1.007	0.099			

OR: odds ratio; CI: confidence interval; BMI: body mass index; HU: hounsfield unite; WBC: white blood cell; Hb: hemoglobine

and 0.645 for stone density (cut-off 782 HU, sensitivity 77.0%, specificity 49.1; p = 0.002). Renal pelvis urine density demonstrated the highest predictive ability with an AUC of 0.744 (cut-off 9.5 HU, sensitivity 73.5%, specificity 71.2; p < 0.001). Stone–skin distance also showed strong predictive capacity (AUC 0.733, cut-off 11.5 cm, sensitivity 71.1%, specificity 70.7; p < 0.001). The ROC characteristics are summarized in **Figure 1** and **Table 3**.

Discussion

Endourological approaches remain the most commonly employed treatment modality for proximal ureteral stones; however, the EAU urolithiasis guideline also recommends SWL for stones smaller than 1 cm [3,9]. SWL is often preferred as an alternative option, particularly for patients who decline surgery or present with clinical factors favoring a less invasive intervention. Despite its noninvasive nature and associated advantages, SWL can lead to complications such as steinstrasse formation, failure of spontaneous fragment passage, pyonephrosis, renal colic, and renal hematoma [10]. These complications may necessitate additional endourological procedures and, particularly in cases

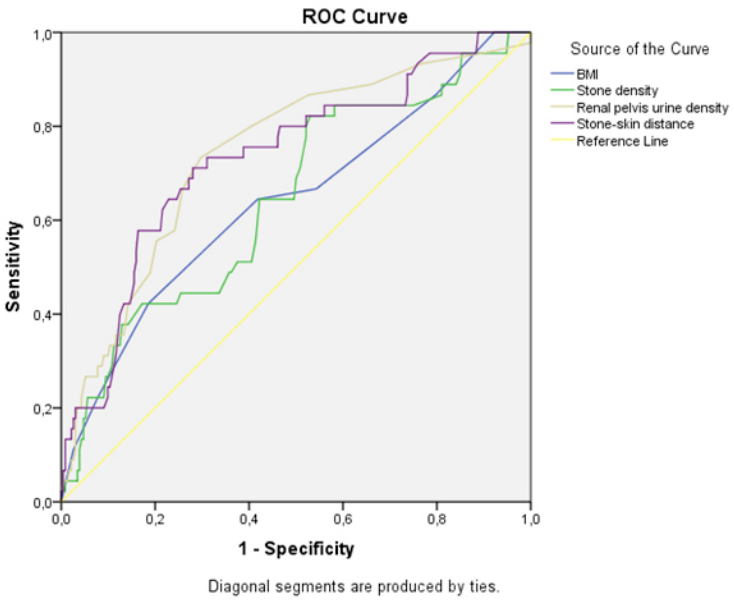

Figure 1. ROC curve of independent risk factors for urgent URS requirement after SWL

Table 3. The predictive capacity of independent risk factors for urgent URS requirement after SWL was examined using ROC analysis.

Variables	Cut-off value	Sensitivity-specificity	AUC	95% CI	P value
BMI (kg/m2)	24.5	(%66.7- %46.4)	.640	.546-.734	**0.003**
Stone density (HU)	782	(%77.0-%49.1)	.645	.555-.735	**0.002**
Renal pelvis urine density	9.5	(%73.5-%71.2)	.744	.664-.825	**<0.001**
Stone-skin distance (cm)	11.5	(%71.1-%70.7)	.733	.651-.816	**<0.001**

of steinstrasse, may reduce overall treatment success while increasing the need for repeated interventions [11,12]. herefore, identifying risk factors that predict the likelihood of requiring URS in patients with proximal ureteral stones may aid in more accurate patient selection for SWL. Although smaller stone size is associated with higher SWL success and forms the basis of the guideline's 1 cm threshold, it should be recognized that other parameters such as stone density, ureteral caliber, and stone–skin distance may negatively influence SWL outcomes and increase the need for additional procedures and healthcare costs [13,14]. Additionally, the role of patient-specific anatomical and physiological factors in influencing SWL outcomes warrants further consideration. Parameters such as ureteral peristaltic activity, degree of hydronephrosis, and renal pelvic morphology may contribute to variations in stone clearance and the need for urgent interventions, yet these factors have not been systematically evaluated in most studies.

Several studies evaluating risk factors for SWL success have identified parameters such as stone size, ureteral wall thickness, stone density, and stone–skin distance as unfavorable determinants. Muter et al. reported that patients with lower stone density achieved higher stone-free rates [15]. Similarly, Ying Lee et al. identified stone size, density, and skin-to-stone distance as significant predictors of stone-free outcomes [16]. Additionally, various nomograms have demonstrated reliable performance in predicting stone-free status; among these, the Dogan and Onal nomogram which incorporate variables such as age, sex, and stone characteristics have been shown to provide effective predictive value [17,18]. Although our study shares certain features with previous research, it primarily focuses on a less explored clinical domain: the identification of parameters associated with the need for urgent ureteroscopy following SWL. We also evaluated anatomical factors, such as stone-skin distance, proximal and distal ureteral diameters and renal pelvis urine density, which may influence stone fragment passage and the likelihood of urgent intervention. Beyond stone-free rates, determining which patients are at risk for requiring urgent endourological intervention represents another clinically important aspect of SWL treatment. According to our literature review, there is limited data about urgent URS requirement. From a clinical perspective, identifying high-risk patients may help guide consideration of alternative treatments and improve pre-procedural counseling. In addition, studies focusing on the success of SWL may lead to the possibility of overlooking the morbidity and costs brought about by the need for urgent URS, and this creates the need for further studies on this subject.

In our retrospective analysis, 16.2% of patients required urgent URS due to renal colic, steinstrasse formation, or pyonephrosis. Across the entire cohort, BMI (OR 1.245, 95% CI 1.025–1.512, p = 0.028), stone density (OR 1.003, 95% CI 1.001–1.004, p = 0.002), renal pelvic urine density (OR 1.032, 95% CI 1.009–1.055, p = 0.006), and stone–skin distance (OR 1.654, 95% CI 0.986–1.446, p = 0.004) emerged as significant predictors of urgent URS. These findings are consistent with previously identified parameters associated with lower SWL success, making their association with urgent intervention unsurprising. Increased BMI and stone–skin distance may reduce the effectiveness of shockwave transmission, potentially contributing to inadequate stone fragmentation. Likewise, stone size continues to influence SWL outcomes, as reported in earlier studies. Notably, renal pelvic urine density derived from NCCT may serve as an early indicator of potential pyonephrosis and appears to be a clinically useful parameter for pre-procedural assessment in SWL candidates. Moreover, integrating these factors into predictive models alongside established variables such as BMI, stone density, and stone–skin distance may improve the accuracy of anticipating which patients are at higher risk for complications or additional procedures.

Our study is not free from limitations due to its retrospective design. The identification of patients who required urgent ureteroscopy based on chart review may have introduced selection bias in determining which patients were classified as needing urgent intervention. Furthermore, the single-center nature of the study, the relatively small sample size, and potential variations related to the center's SWL device, operator experience, and treatment protocols may limit the generalizability of the results. Despite these limitations, the present study represents one of the few investigations in the literature evaluating parameters predictive of urgent endourological intervention following SWL and provides clinically meaningful insights that may guide patient management. Moreover, similar to nomograms developed to predict SWL success, these findings possess characteristics that could serve as a basis for future prospective, randomized controlled studies aimed at identifying factors associated with the need for urgent URS.

Conclusion

This study identified clinical and radiological parameters that predict the need for urgent ureteroscopy following SWL for proximal ureteral stones. BMI, stone density, renal pelvic urine density, and stone–skin distance were found to be significantly associated with the requirement for urgent intervention. Future prospective, multicenter studies are needed to validate such comprehensive predictive approaches, which could ultimately facilitate more personalized treatment planning, reduce unnecessary interventions, and optimize clinical outcomes in patients undergoing SWL for proximal ureteral stones.

Ethics Committee Approval: This study was approved by the Erzurum Medical Faculty Local Ethics Committee (approval number: BAEK 2025/10-265)
Informed Consent: An informed consent was obtained from all the patients.
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Transurethral Ejaculatory Duct Resection in Infertile Patients with Aspermia/ Hypovolemic Ejaculate and Midline Prostatic Cysts: Results of a Long-Term Retrospective Study

Aspermi/Hipovolemik Ejakülat ve Orta Hat Prostat Kistleri Olan İnfertil Hastalarda Transüretral Ejakülatör Kanal Rezeksiyonu: Uzun Dönemli Retrospektif Bir Çalışmanın Sonuçları

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Abstract

Objective: Midline prostatic cysts are extremely rare obstructive causes of male infertility. Transurethral ejaculatory duct resection (TUR-ED) is performed as a treatment modality. This study aims to evaluate the long-term outcomes of TUR-ED.
Materials and Methods: Following approval from the regional ethics committee and in compliance with the Helsinki Declaration, we retrospectively analyzed male patients who presented with infertility and underwent TUR-ED for midline prostatic cysts between January 2015 and June 2024. The patients' medical histories, semen analyses, and imaging findings were reviewed. The surgery was performed by an experienced surgeon using bipolar electrocautery. Postoperative follow-up included assessments of semen parameters, hormone levels, and complications. Statistical analyses were conducted using IBM SPSS version 2020.
Results: A total of 28 patients were included in the study. Postoperatively, a statistically significant improvement was observed in semen volume, sperm concentration, and motility. The most common complications were hemospermia (25%) and epididymitis (10.7%). The mean follow-up period was 12.3 months, and pregnancy was achieved in 42.9% of patients, with 25.0% occurring spontaneously and 17.9% via assisted reproductive techniques.
Conclusion: TUR-ED is an effective surgical treatment that improves semen parameters. Our long-term follow-up results demonstrate its positive impact on reproductive outcomes. However, due to potential complications, patients will be careful selection and close postoperative monitoring are essential.

Keywords: aspermia, ejaculatory duct cyst, male infertility, midline prostatic cyst, TUR-ED

Özet

Amaç: Orta hat prostat kistleri, erkek infertilitesinin oldukça nadir görülen obstrüktif nedenleridir. Transüretral ejakülatör kanal rezeksiyonu (TUR-ED) bir tedavi yöntemi olarak uygulanmaktadır. Bu çalışma, TUR-ED'nin uzun dönem sonuçlarını değerlendirmeyi amaçlamaktadır.
Gereçler ve Yöntemler: Bölgesel etik kurul onayı ve Helsinki Bildirgesi'ne uygun olarak, Ocak 2015 ile Haziran 2024 tarihleri arasında infertilite şikayetiyle başvuran ve orta hat prostat kistleri nedeniyle TUR-ED uygulanan erkek hastalar retrospektif olarak analiz edildi. Hastaların tıbbi öyküleri, semen analizleri ve görüntüleme bulguları incelendi. Ameliyat, bipolar elektrokoter kullanılarak deneyimli bir cerrah tarafından gerçekleştirildi. Ameliyat sonrası takipte semen parametreleri, hormon seviyeleri ve komplikasyonlar değerlendirildi. İstatistiksel analizler IBM SPSS 2020 sürümü kullanılarak yapıldı.
Bulgular: Çalışmaya toplam 28 hasta dahil edildi. Ameliyat sonrası semen hacmi, sperm konsantrasyonu ve motilitesinde istatistiksel olarak anlamlı bir iyileşme gözlendi. En sık görülen komplikasyonlar hemospermi (%25) ve epididimit (%10,7) idi. Ortalama takip süresi 12,3 ay olup, hastaların %42,9'unda gebelik elde edildi; gebelik %25,0'si kendiliğinden, %17,9'u ise yardımcı üreme teknikleriyle sağlandı.
Sonuç: TUR-ED, semen parametrelerini iyileştiren etkili bir cerrahi tedavidir. Uzun dönem takip sonuçlarımız, üreme sonuçları üzerindeki olumlu etkisini göstermektedir. Ancak, olası komplikasyonlar nedeniyle hastaların dikkatli seçilmesi ve ameliyat sonrası yakın takip şarttır.

Anahtar kelimeler: aspermi, ejakülatör kanal kisti, erkek infertilitesi, orta hat prostat kisti, TUR-ED

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Introduction

Infertility is defined as the inability to conceive despite one year of regular, unprotected intercourse and affects 4–17% of couples worldwide [1,2]. Male factors contribute to nearly half of infertility cases, with approximately 20% of infertile men exhibiting severe oligospermia or azoospermia [3,4].

The causes of male infertility are classified as pre-testicular, testicular, and post-testicular [2]. Midline prostatic cysts are considered a correctable post-testicular cause of male infertility [4]. These cysts can lead to partial or complete ejaculatory duct obstruction (EDO) [5]. EDO is identified in 1–5% of men with obstructive infertility [6]. Patients typically present with azoospermia and/or aspermia [7]. Diagnosis is primarily made using transrectal ultrasonography (TRUS) or magnetic resonance imaging (MRI) [5].

Aspermia is defined as the absence of semen during ejaculation, whereas hypovolemic ejaculate refers to an ejaculate volume of less than 0.5 mL. Both conditions are among the rarest causes of male infertility [2,4]. EDOs are included among the obstructive causes of aspermia, and the primary surgical treatment for this condition is transurethral ejaculatory duct resection (TUR-ED). Although alternative approaches such as TRUS-guided cyst aspiration or laser incision have been attempted, their outcomes have not proven as effective as TUR-ED [7].

TUR-ED is a minimally invasive endoscopic procedure that reopens the obstructed ejaculatory duct, facilitating sperm passage [7]. However, limited studies have evaluated the long-term efficacy of this procedure and its impact on fertility, with most available research being case reports. In this study, we aimed to assess the long-term outcomes of TUR-ED in patients with aspermia or hypovolemic ejaculate due to midline prostatic cysts who presented to our clinic with infertility.

Material and Methods

All procedures in this study were conducted in accordance with the Helsinki Declaration and ethical standards. After obtaining approval from the regional ethics committee (Decision No: 2024/07-136), a retrospective review was performed on male patients who presented with infertility between January 2015 and June 2024. Due to the retrospective nature of this study, individual consent was not required by the ethics committee decision. The medical records, surgical notes, anesthesia records, and outpatient follow-up data of patients diagnosed with midline prostatic cysts and who underwent TUR-ED were retrospectively analyzed.

Our hospital has a well-established andrology laboratory and an active in vitro fertilization (IVF) center, providing comprehensive infertility treatment. Infertility surgery has been actively performed in our clinic for over 20 years. Before any treatment, all patients underwent a detailed medical history review, physical examination, hormone profiling, at least two semen analyses, and additional imaging studies such as scrotal ultrasound, TRUS, or MRI. Although TRUS was performed on each patient, MRI was requested for the intermediate cases to confirm the diagnosis. The surgical procedure was carried out on patients whose diagnoses were validated through semen analysis and imaging. The TUR-ED procedure was performed by a single surgeon with over 20 years of experience in infertility surgery.

Patient Selection

Patients diagnosed with primary or secondary aspermia or hypovolemic ejaculate (semen volume ≤0.5 mL) were included in the study. Hypovolemic ejaculate was defined as an ejaculate volume ≤0.5 mL, in accordance with previously published studies and WHO recommendations for the evaluation of EDO [8]. Only patients with EDO and midline prostatic cysts confirmed by TRUS and/or MRI, and who had not undergone previous surgical intervention on the ejaculatory ducts, were eligible for inclusion. Postoperative semen analysis was based on a single semen sample obtained at follow-up.

Exclusion Criteria

Patients with irregular follow-ups and/or insufficient data for the study were excluded.

Surgical Technique

Under regional or general anesthesia, following surgical site sterilization, transurethral access was achieved using a 22–24 Fr resectoscope. Upon reaching the cyst, careful bipolar electrocautery resection was performed. The bladder neck and external urethral sphincter were preserved. To prevent rectal injury, deep resection was avoided. Cauterization was minimized or omitted to prevent ejaculatory duct stenosis. A 16 Fr transurethral (TU) catheter was placed, and the procedure was concluded. TU catheters were removed 12–24 hours postoperatively, and patients were discharged. **Figure 1** illustrates the endoscopic appearance of the midline prostatic cyst, while **Figure 2** demonstrates the fully opened ejaculatory duct following cyst resection.

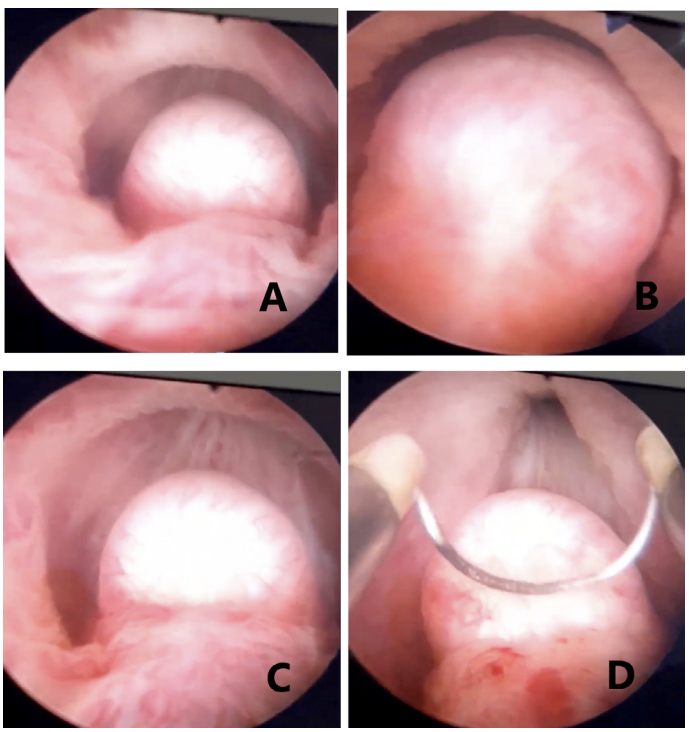

Figure 1. A, B, C, D: Endoscopic appearance of prostate midline cysts; the cysts completely block the ejaculatory ducts and cause obstruction in the urethral lumen.

Follow-up Protocol

Patients were evaluated postoperatively at 1, 3, 6, and 12 months, followed by annual follow-ups. During these visits, semen analyses, ejaculate volume, complications, cyst recurrence, and spontaneous pregnancy outcomes were assessed. Hormone profiles, smoking, and alcohol consumption were also recorded. Patients were referred for assisted reproductive techniques when necessary. Semen and hormonal analyses were conducted according to World Health Organization (WHO) criteria.

Statistical Analysis

Data were analyzed using IBM SPSS version 2020. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean and standard deviation. The distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. For normally distributed parameters, preoperative and postoperative differences were compared using the paired samples t-test. Non-normally distributed data were analyzed using the Wilcoxon test. A p-value <0.05 was considered statistically significant.

Results

A total of 28 patients were included in the study. The mean age of the patients was 30.4 ± 4.9 years. The median cyst diameter was 1.0 [1.0;1.6] cm. The mean operative time was 13.8 ± 4.2 minutes.

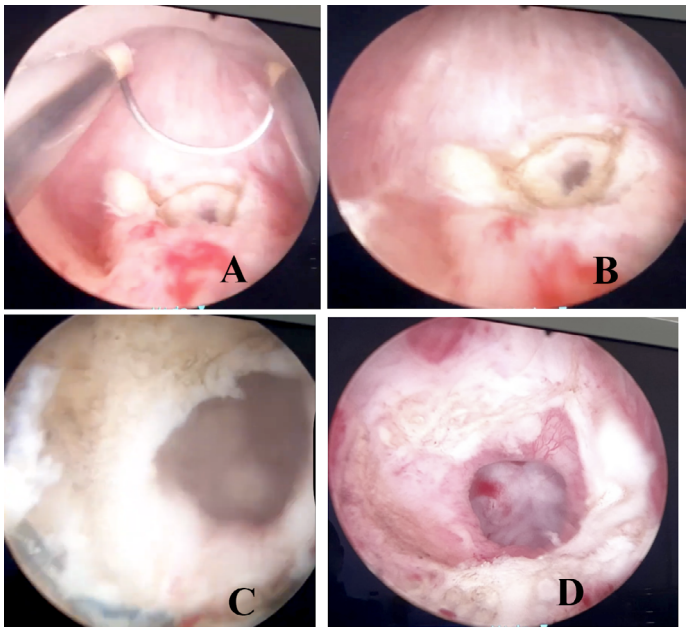

Figure 2. A, B, C, D: After TUR-ED, the ejaculatory ducts and urethra are seen to be fully opened.

Preoperative semen parameters were recorded as follows: mean semen volume of 0.2 ± 0.2 mL, sperm concentration of 2.1 ± 4.7 million/mL, and progressive motility of 3.0 ± 7.0%. Postoperatively, a statistically significant improvement was observed, with mean semen volume increasing to 0.8 ± 0.3 mL,

Table 1. Demographic, clinical, perioperative, and postoperative data of patients

Parameter			
Patient number, n	28	-	-
Mean age ± SD (years)	30.4 ± 4.9	-	-
Median cyst diameter (IQR, cm)	1.0 [1.0; 1.6]	-	-
Mean operation time ± SD (min.)	13.8 ± 4.2	-	-
Mean follow-up time ± SD (month)	12.3 ± 3.2	-	-
Pregnancy number, n (%)	12 (42.9)	-	-
Spontaneous	7 (25.0)	-	-
With assisted reproductive techniques	5 (17.9)	-	-
Postoperative complications, n (%)	-	-	-
None	18 (64.3)	-	-
Hemospermia	7 (25.0)	-	-
Epididymitis	3 (10.7)	-	-
Recurrence	0 (0.0)	-	-
Urethral Stricture	0 (0.0)	-	-
Other	0 (0.0)	-	-
Parameter	**Preoperative**	**Postoperative**	**P-value**
Mean semen volume ± SD, ml	0.2 ± 0.2	0.8 ± 0.3	<0.001[a]
Mean sperm concentration ± SD, million/ml	2.1 ± 4.7	7.2 ± 6.5	<0.001[a]
Mean progressive motility ± SD, percentage	3.0 ± 7.0	12.5 ± 11.9	<0.001[a]
Mean total testosterone ± SD, ng/ml	421.1 ± 90.4	420.4 ± 87.2	0.897[a]
Median FSH (IQR), IU/L	3.0 [2.0; 4.0]	3.0 [2.1; 4.2]	0.964[b]

a Paired samples t-test; b Wilcoxon test

sperm concentration to 7.2 ± 6.5 million/mL, and progressive motility to 12.5 ± 11.9% ($p<0.05$). While 75% of the patients (n=21) were azoospermic in the preoperative period, only 21.42% (n=6) remained azoospermic postoperatively (**Table 1**).

Mean testosterone levels and median FSH levels remained within normal ranges preoperatively and postoperatively, showing no significant difference between the two periods ($p>0.05$) (**Table 1**).

During postoperative follow-up, hemospermia was observed in 7 patients (25%) and epididymitis in 3 patients (10.7%). Epididymitis was successfully treated with antibiotic therapy, while hemospermia resolved spontaneously without intervention. No cases of incontinence, rectal injury, cyst recurrence, urethral or ejaculatory duct stricture, or retrograde ejaculation were reported.

The mean follow-up period was 12.3 ± 3.2 months. Pregnancy was achieved in 42.9% of patients, with 25.0% occurring spontaneously and 17.9% via assisted reproductive techniques. A history of smoking was noted in 46.4% (n=13) of patients, while alcohol consumption was reported in 3 patients (10.7%). The demographic, preoperative, and postoperative data of the patients are presented in **Table 1**.

Discussion

TUR-ED is recognized as an effective and safe surgical approach for the treatment of EDO [7-10]. In the literature, partial studies and case reports evaluating TUR-ED outcomes have demonstrated improvements in spontaneous pregnancy rates and conception via assisted reproductive techniques [11,12]. Reports indicate that sperm passage is restored in approximately 60–70% of patients following TUR-ED, with spontaneous pregnancy rates ranging from 12% to 30% [4,9,12-14]. Additionally, studies have shown an increased likelihood of conception with intrauterine insemination (IUI) [15]. One study reported a pregnancy rate of 41.6%, with 25% of patients achieving spontaneous pregnancy [16]. Similarly, in our study, significant improvements were observed in semen parameters and ejaculate volume, with pregnancy achieved in 42.9% of patients, with 25.0% occurring spontaneously and 17.9% via assisted reproductive techniques.

Several studies have reported improvements in semen parameters following TUR-ED, with success rates ranging from 63% to 83% [9,14,17,18]. Other studies have demonstrated a 90% increase in semen volume and up to a 50% improvement in sperm count [19,20]. In our study, preoperatively, the mean semen volume was 0.2 ± 0.2 mL, sperm concentration 2.1 ± 4.7 million/mL, and progressive motility 3.0 ± 7.0%. Postoperative values significantly improved to 0.8 ± 0.3 mL, 7.2 ± 6.5 million/mL, and 12.5 ± 11.9%, respectively ($p<0.05$). Azoospermia was present in 75% (n=21) of patients before surgery, but only 21.4% (n=6) remained azoospermic afterward. Our long-term follow-up results confirm the effectiveness of TUR-ED, particularly in increasing ejaculate volume and facilitating sperm passage. However, semen parameters did not improve in some patients. Although factors that may significantly affect spermatogenesis—such as a solitary testis, prior use of anabolic steroids or testosterone, cystic fibrosis, a history of testicular malignancy, or other embryological abnormalities—could be among the underlying genitourinary causes, such data were not accessible through the patients' medical records [1]. While this raises the possibility of epididymal reflux and/or testicular damage due to prolonged obstruction, other potential causes should also be considered.

Studies have demonstrated that in patients with obstructive azoospermia or aspermia, testicular function remains intact, as evidenced by normal levels of FSH and total testosterone [1,21]. In our study, both preoperative and postoperative measurements of FSH and total testosterone were found to be within normal ranges.

The reported complications of TUR-ED include urinary reflux into the ejaculatory ducts and seminal vesicles, epididymo-orchitis, hematuria, acute urinary retention, retrograde ejaculation, and incontinence [7]. Studies have reported postoperative complication rates ranging from 4% to 26% [7,20-24]. Some reports also indicate that secondary ejaculatory duct stenosis may develop after TUR-ED, with azoospermia occurring in up to 27% of cases, necessitating repeat TUR-ED [6,24,25]. In our study, postoperative complications included hemospermia in 25% and epididymitis in 10.7% of patients. No other complications, such as incontinence, rectal injury, cyst recurrence, urethral or ejaculatory duct stricture, or retrograde ejaculation, were observed.

If sperm are detected in the preoperative semen analysis, cryopreservation is recommended to safeguard against the risk of postoperative azoospermia [7]. In our study, cryopreservation was recommended for patients in whom sperm were detected in the preoperative semen analysis, to be used if necessary in subsequent assisted reproductive techniques and as a precaution against the risk of postoperative azoospermia.

Given the scarcity of studies assessing the long-term outcomes, adverse effects, and fertility implications of TUR-ED, we believe our findings provide meaningful contributions to the existing literature.

Our study has several limitations. The retrospective design and relatively small sample size may limit the generalizability of the results. Additionally, the lack of a control group and potential selection bias should be considered when interpreting the findings. Future prospective, multicenter studies with larger cohorts and longer follow-up periods are warranted to confirm and expand upon these results. Another limitation of this study is that all procedures were performed by a single surgeon, which may limit the generalizability of the results and represent a potential source of operator-related bias.

Conclusion

TUR-ED is an effective surgical technique for improving semen parameters in patients with midline prostatic cysts. Our long-term follow-up results indicate that TUR-ED positively contributes to fertility outcomes while maintaining a low complication rate. However, careful patient selection and long-term postoperative monitoring are essential to optimize outcomes.

Ethics Committee Approval: This study was approved by the Erzurum Medical Faculty Local Ethics Committee (approval number: BAEK 2024/07-136)

Informed Consent: An informed consent was obtained from all the patients.
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Predictive Value of Pathological Vein Diameter for Semen Improvement After Varicocelectomy

Varikokelektomi Sonrası Semen Kalitesinin İyileşmesinde Patolojik Damar Çapının Öngörü Değeri

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Abstract

Objective: To compare the predictive value of clinical varicocele grade, color Doppler ultrasonography (CDUS)–measured venous diameter and pathologically measured venous diameter in predicting postoperative semen parameter improvement after microsurgical varicocelectomy.
Materials and Methods: This retrospective observational study included patients who underwent unilateral subinguinal microsurgical varicocelectomy between January 2022 and June 2025. Preoperative CDUS venous diameters (at rest and during Valsalva), clinical varicocele grade, intraoperatively excised pathological venous diameters, and semen analysis parameters were recorded. Improvement after varicocelectomy was defined as a ≥10% increase in sperm concentration and/or progressive motility. Correlation analyses and univariate and multivariate logistic regression models were used to identify predictors of postoperative improvement.
Results: A total of 55 patients were analyzed, of whom 44 (80.0%) demonstrated postoperative improvement in semen parameters. Pathological venous diameter was significantly larger in the improved group compared with the non-improved group (3.30 vs. 2.98 mm, p = 0.026). Pathological venous diameter showed a significant positive correlation with clinical grade (r = 0.307, p = 0.023), but not with CDUS-measured venous diameters. In multivariate analysis, higher clinical grade (Grade 2: OR = 4.523; Grade 3: OR = 6.544), larger pathological venous diameter (OR = 2.149), and lower preoperative sperm concentration (OR = 0.928) were independent predictors of postoperative semen improvement. CDUS-derived venous diameters were not predictive.
Conclusion: Pathological venous diameter and clinical varicocele grade appear to be more informative than CDUS-measured venous diameter in predicting semen parameter improvement after varicocelectomy. These findings suggest that the anatomical extent of venous dilation may better reflect the potential reversibility of varicocele-related testicular dysfunction.

Keywords: varicocele, varicocelectomy, semen analysis, color doppler ultrasonography, venous diameter

Özet

Amaç: Bu çalışmada, mikroskobik varikoselektomi sonrası semen parametrelerindeki iyileşmeyi öngörmede klinik varikosel evresi, renkli Doppler ultrasonografi (RDUS) ile ölçülen ven çapı ve patolojik olarak ölçülen ven çapının prediktif değerlerinin karşılaştırılması amaçlanmıştır.
Gereçler ve Yöntemler: Ocak 2022–Haziran 2025 tarihleri arasında unilateral subinguinal mikroskobik varikoselektomi uygulanan hastalar retrospektif olarak değerlendirildi. Preoperatif RDUS ile istirahat ve Valsalva sırasında ölçülen ven çapları, klinik varikosel evresi, intraoperatif olarak çıkarılan venlerin patolojik çapları ve semen analiz sonuçları kaydedildi. Varikoselektomi sonrası iyileşme, sperm konsantrasyonu ve/veya progresif motilitede ≥%10 artış olarak tanımlandı. Postoperatif iyileşmenin öngörücüleri korelasyon analizleri ile birlikte univaryant ve multivaryant lojistik regresyon analizleri kullanılarak değerlendirildi.
Bulgular: Toplam 55 hasta analiz edildi ve bunların 44'ünde (%80) semen parametrelerinde postoperatif iyileşme saptandı. Patolojik ven çapı, iyileşme gösteren grupta göstermeyen gruba kıyasla anlamlı derecede daha büyüktü (3.30 vs. 2.98 mm; p = 0.026). Patolojik ven çapı ile klinik evre arasında anlamlı pozitif korelasyon saptanırken (r = 0.307; p = 0.023), RDUS ile ölçülen ven çapları ile anlamlı bir ilişki izlenmedi. Multivaryant analizde; daha yüksek klinik evre (Evre 2: OR = 4.523; Evre 3: OR = 6.544), daha büyük patolojik ven çapı (OR = 2.149) ve daha düşük preoperatif sperm konsantrasyonu (OR = 0.928) postoperatif semen iyileşmesinin bağımsız öngörücüleri olarak belirlendi. RDUS kaynaklı ven çapları prediktif bulunmadı.
Sonuç: Patolojik ven çapı ve klinik varikosel evresi, varikoselektomi sonrası semen parametrelerindeki iyileşmeyi öngörmede RDUS ile ölçülen ven çapına kıyasla daha bilgilendirici görünmektedir. Bu bulgular, venöz dilatasyonun anatomik boyutunun varikosele bağlı testiküler disfonksiyonun potansiyel geri dönüşünü daha iyi yansıtabileceğini düşündürmektedir.

Anahtar kelimeler: varikosel, varikoselektomi, semen analizi, renkli doppler ultrasonografi, ven çapı

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Introduction

Varicocele, defined as the dilation and reflux of the pampiniform plexus veins, represents the most common and surgically correctable cause of male infertility [1]. It is identified in approximately 15% of men with primary infertility and up to 80% of those with secondary infertility [2]. The detrimental effects of varicocele on spermatogenesis have long been recognized, with several pathophysiological mechanisms, such as testicular hyperthermia, increased oxidative stress, hormonal dysfunction, and venous stasis, proposed to underlie impaired testicular function [3].

Although physical examination remains the cornerstone of diagnosis, its observer-dependent nature limits diagnostic accuracy [4]. Therefore, scrotal color Doppler ultrasonography (CDUS) has become a widely accepted complementary tool for confirming varicocele and assessing its severity [5]. Scrotal color Doppler ultrasonography provides an objective and quantitative assessment that supports clinical examination, as emphasized in previous reports [6]. In routine practice, a venous diameter >3 mm and reflux lasting longer than 2 seconds during the Valsalva maneuver are commonly regarded as diagnostic thresholds for clinical varicocele [7,8]. Furthermore, Schiff et al. reported in 2006 that patients with a venous diameter ≥3 mm accompanied by Valsalva-induced reflux experienced significant postoperative improvements in sperm count and motility [9].

However, the extent to which ultrasonographically measured venous diameters correspond to the actual macroscopic and morphological characteristics of dilated veins removed during surgery remains insufficiently investigated [10,11]. Only one study to date has shown that intraoperative venous diameters are systematically underestimated by preoperative CDUS [12]. The relationship between surgically measured venous size and postoperative semen improvement, or broader clinical infertility outcomes, thus remains unclear, representing a notable gap in the literature.

Our study aims to address this gap by evaluating the correlation between preoperative CDUS findings and intraoperative venous measurements, as well as exploring the association between surgically measured venous dimensions and postoperative semen parameters.

Material and Methods

This retrospective observational study was conducted by reviewing the medical records of patients who underwent microsurgical varicocelectomy between January 2022 and June 2025. Ethical approval was obtained from the institutional review board on 17 July 2025 (Protocol No. 12/23). No additional interventions were performed, and all data were extracted from the hospital's electronic medical record system.

A priori sample size calculation was performed based on the primary objective of assessing the association between two continuous variables (ultrasonographic vein diameter and surgically measured vein diameter) using correlation analysis. Using G*Power version 3.1, and assuming a moderate effect size ($r = 0.40$), a two-sided alpha level of 0.05, and 80% power ($1–\beta = 0.80$), the minimum required sample size was calculated as 47 patients. In addition, for the secondary outcome evaluating postoperative semen improvement, defined as a ≥10% increase in sperm concentration and/or progressive motility, an a priori sample size calculation was also performed. The calculation was based on a within-patient pre–post comparison of continuous semen parameters underlying this improvement definition. Assuming a moderate standardized effect size (Cohen's $d = 0.40$), a two-sided alpha level of 0.05, and 80% power ($1–\beta = 0.80$), a minimum sample size of approximately 50 patients was required.

A total of 55 patients aged 18–45 years who had a CDUS and underwent unilateral subinguinal microsurgical varicocelectomy were included. Exclusion criteria were: (i) previous scrotal surgery, (ii) bilateral varicocelectomy, (iii) missing or incomplete CDUS data, and (iv) incomplete follow-up records.

Preoperative CDUS data were obtained from archived radiology reports. All examinations were performed with the patient in the standing position, both at rest and during the Valsalva maneuver. For each patient, the maximum venous diameter measured at rest and during Valsalva was recorded.

During surgery, the dilated pampiniform plexus veins were excised and appropriately submitted to the pathology department. In the pathology unit, all venous segments were measured in millimeters, and the largest venous diameter for each patient was recorded.

Demographic characteristics [age, body mass index (BMI)], clinical parameters (presence of testicular atrophy, clinical grade), semen analysis results (concentration, progressive motility, morphology), preoperative CDUS venous diameters, and pathological venous diameters were evaluated. Testicular atrophy was determined based on CDUS-measured testicular volumes. Postoperative semen parameters were derived from sperm analysis performed at 6 months. Testicular volumes were calculated using the Lambert formula, and a reduction of more than 20% in the volume of the affected testis compared with the contralateral testis was considered indicative of testicular atrophy.

Previous studies have demonstrated that varicocelectomy typically results in an average improvement of approximately 9–10% in sperm concentration or progressive motility, a change considered clinically meaningful [13]. Therefore, improvement after varicocelectomy was defined as a ≥10% increase in sperm concentration and/or progressive motility in the postoperative semen analysis.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 25.0. Normality of continuous variables was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Continuous variables were expressed as mean ± SD or median (IQR), and categorical variables as frequencies and percentages. Correlations between pathological vein diameter and clinical/imaging variables were evaluated using Pearson or Spearman correlation analyses according to data distribution. To identify factors predicting postoperative improvement in semen parameters, a univariate logistic regression analysis was first conducted, and variables with a p value <0.20 were subsequently included in the multivariate logistic regression model. A two-tailed p value <0.05 was considered statistically significant.

Table 1. Demographic and clinical characteristics of the cohort

Variables	All, n= 55	Non-improved group, n=11	Improved group, n= 44	P
Age (years), mean±SD	30.09±7.17	30.18±9.98	30.07±6.43	0.963
BMI (kg/m²), median (IQR)	23.80 (5.10)	24.20 (4.60)	23.50 (5.25)	0.307
Testicular atrophy				
No, n (%)	49 (83.6)	9 (81.8)	37 (84.1)	0.657
Yes, n (%)	9 (16.4)	2 (18.2)	7 (15.9)	
Clinical grade				
1, n (%)	8 (14.5)	4 (36.4)	7 (6.8)	**0.049**
2, n (%)	27 (49.1)	5 (45.5)	24 (54.5)	
3, n (%)	20 (36.4)	2 (18.2)	13 (38.6)	
Preoperative vein diameter (rest) (mm), median (IQR)	3.00 (1.30)	3.00 (1.90)	3.00 (1.25)	0.533
Preoperative vein diameter (Valsalva) (mm), median (IQR)	3.60 (1.50)	3.70 (1.60)	3.60 (1.20)	0.332
Preoperative sperm motility percentage, median (IQR)	22.00 (31.00)	45.00 (66.00)	20.50 (24.00)	0.332
Postoperative sperm motility percentage, median (IQR)	36.00 (32.00)	10.00 (60.20)	36.50 (21.75)	**0.042**
Preoperative sperm concentration (million/mL), median (IQR)	4.00 (7.80)	15.00 (31.90)	3.60 (6.08)	0.146
Postoperative sperm concentration (million/mL), median (IQR)	8.00 (21.80)	4.50 (26.20)	8.25 (20.95)	0.274
Preoperative normal morphology percentage, median (IQR)	1 (2)	1(2)	1(2)	0.297
Postoperative normal morphology percentage, median (IQR)	1 (2)	2 (2)	1 (2)	0.956
Pathological vein diameter (mm), median (IQR)	3.20 (0.97)	2.98 (1.18)	3.30 (0.97)	**0.026**

SD: standard deviation; BMI: body mass index; IQR: interquartile range. Values shown in bold indicate statistical significance ($p < 0.05$).

Results

The demographic, clinical, CDUS, and semen parameters of the entire cohort, along with the comparisons between patients with and without improvement in semen parameters, are presented in **Table 1**. The mean age was 30.09 ± 7.17 years and the median BMI was 23.80 (IQR: 5.10) kg/m². Testicular atrophy was present in 16.4% of the cohort. Clinical grading showed that 14.5% of patients were classified as Grade 1, 49.1% as Grade 2, and 36.4% as Grade 3. Preoperative CDUS revealed a median venous diameter of 3.00 mm (IQR: 1.30) at rest and 3.60 mm (IQR: 1.50) during the Valsalva maneuver. The median pathological venous diameter was 3.20 mm (IQR: 0.97).

Postoperative semen analysis demonstrated overall improvement in sperm parameters. Median progressive sperm motility increased from 22.0% (IQR: 31.0) preoperatively to 36.0% (IQR: 32.0) postoperatively, and median sperm concentration increased from 4.00 (IQR: 7.80) million/mL to 8.00 (IQR: 21.80) million/mL. Sperm morphology did not show any significant change. Based on the study definition of benefit, an increase of at least 10% in sperm concentration and/or motility, 44 patients (80.0%) were categorized into the improved group, while 11 patients (20.0%) showed no meaningful improvement.

Comparison between the improved and non-improved groups revealed no significant differences in age, BMI, presence of testicular atrophy, CDUS-measured preoperative venous diameters, or preoperative semen parameters (all $p > 0.05$). However, pathological venous diameter was significantly larger in the improved group compared with the non-improved group (3.30 mm vs. 2.98 mm; $p = 0.026$). Clinical grade distribution

Table 2. Correlation analysis between pathological venous diameter and clinical grade, preoperative resting vein diameter, and Valsalva vein diameter

Variables	Spearman's rho	95% CI	P
Clinical grade	0.307	0.037-0.535	**0.023**
Preoperative vein diameter (rest)	0.255	-0.019-0.494	0.060
Preoperative vein diameter (Valsalva)	0.247	-0.028-0.487	0.069

CI: confidence interval. Values shown in bold indicate statistical significance ($p < 0.05$).

Table 3. Univariate and multivariate logistic regression analysis for predictors of improvement after varicocelectomy

Variables	Univariate			Multivariate		
	OR	95% CI	p	OR	95% CI	P
Age (years)	0.998	0.909–1.095	0.962			
BMI (kg/m²)	0.893	0.704–1.133	0.352			
Testicular atrophy						
No	Reference					
Yes	0.831	0.220–3.142	0.785			
Clinical grade						
1	Reference					
2	2.400	1.079–5.960	**0.041**	4.523	1.968–15.407	**0.018**
3	3.333	1.395–7.056	**0.023**	6.544	1.350–15.582	**0.031**
Preoperative vein diameter (rest) (mm)	0.672	0.353–1.280	0.227			
Preoperative vein diameter (Valsalva) (mm)	0.658	0.350–1.235	0.192	0.715	0.197–2.592	0.609
Preoperative sperm motility percentage	0.975	0.945–1.005	0.106	0.986	0.947–1.027	0.499
Preoperative sperm concentration (million/mL)	0.925	0.867–0.986	**0.018**	0.928	0.862–0.999	**0.048**
Preoperative normal morphology percentage	0.714	0.388–1.314	0.279			
Pathological vein diameter (mm)	1.384	1.065–6.751	**0.039**	2.149	1.115–8.562	**0.049**

BMI: body mass index; OR: odds ratio; CI: confidence interval. Variables with a univariate p-value <0.20 were included in the multivariate model. Values shown in bold indicate statistical significance ($p < 0.05$).

also differed between the groups ($p = 0.049$), with Grade 3 varicocele being more frequent in the improved group and Grade 1 more common in the non-improved group.

The correlation analysis examining the relationship between pathological venous diameter and preoperative CDUS-measured venous diameters at rest and during the Valsalva maneuver, as well as clinical varicocele grade, is presented in **Table 2**. Correlation analysis demonstrated that pathological venous diameter had a significant positive correlation with clinical grade ($r = 0.307$; 95% CI: 0.037–0.535; $p = 0.023$). In contrast, no statistically significant correlation was observed between pathological venous diameter and ultrasonographically measured venous diameters, either at rest ($r = 0.255$; $p = 0.060$) or during the Valsalva maneuver ($r = 0.247$; $p = 0.069$).

The logistic regression analysis performed to identify independent predictors of improvement in semen parameters is presented in **Table 3**. Multivariate results showed that higher clinical grade was independently associated with a greater likelihood of postoperative improvement (Grade 2: OR = 4.523, $p = 0.018$; Grade 3: OR = 6.544, $p = 0.031$). Lower preoperative sperm concentration also predicted improvement (OR = 0.928; $p = 0.048$). Additionally, pathological venous diameter emerged as an independent predictor of postoperative benefit (OR = 2.149; $p = 0.049$). No significant associations were found for age, BMI, testicular atrophy, preoperative venous diameters, motility, or morphology.

Discussion

In this study, we investigated the relationship between preoperative CDUS findings, surgically excised venous dimensions, and postoperative semen outcomes in patients undergoing microsurgical varicocelectomy. The key finding of our analysis is that the pathological venous diameter, rather than the CDUS-measured vein diameter, demonstrated a significant association with both clinical varicocele grade and postoperative improvement in semen parameters. Although CDUS remains a widely used diagnostic tool, its measurements showed no significant correlation with the actual venous size determined by pathology. Importantly, clinical grade, larger pathological venous diameter, and lower preoperative sperm concentration emerged as independent predictors of postoperative improvement.

Color Doppler ultrasonography is widely used as a complementary tool in varicocele evaluation, yet previous evidence shows that both its diagnostic performance and its ability to predict varicocelectomy outcomes remain inconsistent. Cocuzza et al. demonstrated that the diagnostic accuracy of physical examination varies significantly according to examiner experience, while CDUS provides a more objective and standardized assessment that improves interobserver agreement compared with physical examination alone [11]. However, Wosnitzer et al. reported that preoperative ultrasound measurements systematically underestimate venous diameter

relative to intraoperative findings, indicating a structural discrepancy between sonographic appearance and true anatomic vein size [12]. Regarding postoperative semen improvement, Schiff et al. showed that men with a venous diameter ≥3 mm accompanied by Valsalva-induced reflux experienced significantly greater gains in sperm concentration and motility following varicocelectomy [9]. In contrast, Babai et al. found that CDUS-detected reflux had no measurable effect on baseline semen parameters and did not predict postoperative improvement [14]. In the present study results also indicate that CDUS-derived venous measurements alone do not reliably reflect the true venous anatomy and are limited in predicting varicocelectomy success. Instead, pathologically measured venous diameter, together with clinical varicocele grade emerged as the parameters most closely associated with postoperative semen improvement, suggesting that true anatomic dilatation may better capture the reversible pathophysiological burden of varicocele.

Because pathological venous diameter is obtained intraoperatively and confirmed postoperatively, it cannot be used for preoperative patient evaluation, surgical indication, or decision-making. Therefore, its clinical utility differs fundamentally from that of clinical varicocele grade and preoperative CDUS parameters. Nevertheless, pathological vein diameter appears to reflect the true anatomic severity of venous dilatation more accurately than ultrasonographic measurements and may be more closely associated with the reversibility of varicocele-related testicular dysfunction. From a practical perspective, this finding mainly informs postoperative patient counselling, as larger excised venous diameters are associated with a higher likelihood of meaningful improvement in semen parameters. Indirectly, it also reinforces the importance of careful physical examination and clinical grading over sole reliance on CDUS-derived vein diameter in routine clinical practice.

The lack of correlation between CDUS-measured venous diameters and pathological vein size in our study can be explained by several technical and physiological factors known to affect ultrasonographic assessment. Venous measurements on CDUS are influenced by probe pressure, patient position, and dynamic venous distension, which can lead to systematic underestimation [12]. The finding that pathological venous diameter correlates with postoperative semen improvement may reflect the greater reversibility of advanced venous congestion: larger varicoceles are associated with more pronounced testicular hyperthermia, oxidative stress, and impaired spermatogenesis [3,15,16]. Thus, once abnormal venous drainage is corrected surgically, men with more severe underlying venous dilation may experience greater functional recovery. The independent predictive value of higher clinical grade is aligned with this interpretation, as clinical grading reflects the degree of venous dilation and reflux. Furthermore, the association between lower preoperative sperm concentration and greater postoperative improvement is consistent with prior evidence showing that men with more severely impaired baseline semen parameters often exhibit the most measurable postoperative gains following varicocelectomy [13].

A major strength of this study is that it directly compares preoperative CDUS findings with pathologically measured venous diameters, a relationship that has received limited attention in the literature. The use of homogeneous surgical technique performed by a single experienced microsurgeon minimizes procedural variability and enhances internal validity. Additionally, the integration of imaging, clinical, pathological, and postoperative semen parameters provides a comprehensive assessment of factors influencing reproductive outcomes after varicocelectomy.

However, several limitations must be acknowledged. The retrospective design introduces inherent risks of missing data and potential selection bias. Pathological venous measurements may be influenced by tissue handling and formalin fixation, which can introduce minor variations compared with in vivo anatomy. Semen analysis results are subject to natural intra-individual variability, and multiple ejaculates were not consistently available for all patients. Additionally, although semen improvement was assessed, patients' actual fertility outcomes were not evaluated, representing an important limitation. Furthermore, because this was a single-center study with a relatively modest sample size, the generalizability of the findings may be restricted. Prospective multicenter studies with standardized intraoperative venous measurements are needed to validate these observations and to better define the prognostic value of actual venous morphology in predicting postoperative reproductive outcomes.

Conclusion

In conclusion, pathological venous diameter emerged as a significant predictor of postoperative improvement in semen parameters, whereas CDUS-measured vein diameters showed no meaningful correlation with either actual venous anatomy or reproductive outcomes. Clinical grade and lower preoperative sperm concentration were also independently associated with greater postoperative benefit. These findings suggest that the true structural severity of venous dilation, better reflected by pathological measurement than by ultrasonography, may play a more decisive role in the reversibility of varicocele-related testicular dysfunction. Further prospective studies incorporating standardized intraoperative measurements are warranted to validate these results and refine prognostic assessment in men undergoing varicocelectomy.

Ethics Committee Approval: Ethical approval was obtained from the Ethics Committee of Antalya Training and Research Hospital on 17 July 2025 (Protocol No. 12/23).
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Case Report – Urologic Oncology
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Angioleiomyoma of the Kidney: Differentiating the Rare Benign Histology from the More Sinister Malignant Tumors of Kidney- A Case Report

Böbreğin Anjioleiomyomu: Nadir Görülen İyi Huylu Histolojinin Böbreğin Daha Tehlikeli Kötü Huylu Tümörlerinden Ayırt Edilmesi - Bir Olgu Sunumu

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Abstract

Renal angioleiomyoma is an exceptionally rare benign mesenchymal tumor, with fewer than five cases documented in the literature. Histologically, it is composed of proliferating smooth muscle cells intersected by branching, slit-like vascular channels and typically lacks significant epithelial components. Despite its benign nature, its morphological overlap with certain renal malignancies presents a diagnostic challenge. Notably, renal cell carcinoma with angioleiomyoma-like stroma, a recently recognized variant of renal cell carcinoma, demonstrates a histologically and immunohistochemically similar stromal component. Although it generally exhibits a more indolent clinical course, there have been reports of lymph node involvement, underscoring its malignant potential. In this report, we present a case of renal angioleiomyoma and discuss the importance of distinguishing it from its malignant counterpart. Histopathological evaluation, supplemented by immunohistochemistry, plays a vital role in achieving a definitive diagnosis. Accurate differentiation is crucial to avoid overtreatment and to ensure appropriate clinical management. The overall prognosis is excellent, reflecting the inherent benign nature of renal angioleiomyoma. No routine long-term surveillance is required once a diagnosis is accurately confirmed. However, pathological overlap with renal cell carcinoma with angioleiomyoma-like stroma may necessitate selective follow-up in cases of diagnostic ambiguity. Improved awareness of renal angioleiomyoma helps ensure correct diagnosis and prevents confusion with malignant or other benign mesenchymal tumors that involve the kidney.

Keywords: angioleiomyoma, renal cell carcinoma with angioleiomyoma like stroma, immunohistochemistry

Özet

Renal anjiyoleyomiyom, literatürde beşten az vakası belgelenmiş, son derece nadir görülen iyi huylu bir mezenkimal tümördür. Histolojik olarak, dallanan, yarık benzeri vasküler kanallarla kesişen prolifere düz kas hücrelerinden oluşur ve tipik olarak önemli epitelyal bileşenlerden yoksundur. İyi huylu yapısına rağmen, bazı renal malignitelerle morfolojik örtüşmesi tanısal zorluk yaratmaktadır. Özellikle, renal hücreli karsinomun yeni tanımlanmış bir varyantı olan anjiyoleyomiyom benzeri stromalı renal hücreli karsinom, histolojik ve immünohistokimyasal olarak benzer bir stromal bileşen göstermektedir. Genellikle daha yavaş bir klinik seyir göstermesine rağmen, malign potansiyelini vurgulayan lenf nodu tutulumu bildirilmiştir. Bu raporda, bir renal anjiyoleyomiyom olgusu sunulmakta ve onu malign muadilinden ayırmanın önemini tartışmaktayız. İmmünohistokimya ile desteklenen histopatolojik değerlendirme, kesin tanıya ulaşmada hayati bir rol oynamaktadır. Doğru ayrım, aşırı tedaviden kaçınmak ve uygun klinik yönetimi sağlamak için çok önemlidir. Genel prognoz, renal anjiyoleyomiyomun doğal iyi huylu yapısını yansıtacak şekilde mükemmeldir. Tanı doğru bir şekilde doğrulandıktan sonra rutin uzun süreli gözetim gerekmez. Ancak, anjiyoleyomiyom benzeri stromalı renal hücreli karsinom ile patolojik örtüşme, tanı belirsizliği olan vakalarda seçici takip gerektirebilir. Renal anjiyoleyomiyom konusunda farkındalığın artırılması, doğru tanıyı sağlamaya yardımcı olur ve böbreği tutan malign veya diğer iyi huylu mezenkimal tümörlerle karışıklığı önler.

Anahtar kelimeler: anjiyoleyomiyom, anjiyoleyomiyom benzeri stromalı renal hücreli karsinom, immünohistokimya

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Introduction

Approximately 20% of renal masses clinically suspected to be malignant are ultimately identified as benign on final histopathological examination following surgical resection [1]. Angioleiomyomas are benign smooth muscle tumors that most commonly arise in the skin and subcutaneous tissue, while their occurrence in visceral organs, including the kidney, is exceedingly rare [2]. Despite their rarity, angioleiomyomas represent the most common benign mesenchymal tumors of the kidney. To date, fewer than five cases of renal angioleiomyoma have been reported in the literature. This highlights the rarity and diagnostic challenge posed by this entity. Herein, we report an unusual case of renal angioleiomyoma in a young female. We emphasize the importance of distinguishing it from its malignant mimics, particularly renal cell carcinoma with angioleiomyoma-like stroma (RCC-AMLSt), as well as other morphologically similar renal tumors. Accurate diagnosis is crucial to prevent unnecessary aggressive treatment and ensure effective patient management.

Case

A 34-year-old female presented with a two-year history of dull, aching pain localized to the right flank. A contrast-enhanced computed tomography (CECT) scan of the whole abdomen revealed a 5.2x4.6x3.8 cm heterogeneously enhancing, predominantly exophytic mass arising from the upper pole of the right kidney, with angiography suggestive of the presence of two renal arteries and two renal veins on the right side **(Figure 1a, 1b)**. Given the radiologically confirmed solid enhancing renal mass, a preliminary diagnosis of renal cell carcinoma (RCC) was made, and the patient underwent robot-assisted laparoscopic right partial nephrectomy using the Da Vinci Xi robotic system. Intraoperatively, a 6x5 cm well-defined, irregularly lobulated, exophytic tumor measuring approximately was identified on the posterior aspect of the upper pole of the right kidney **(Figure 1c, 1d)**. The lesion demonstrated preserved fat planes with adjacent structures and had extensive peritumoral neovascularization. The tumor was excised with an adequate surgical margin, followed by renorrhaphy. The warm ischemia time was 25 minutes, and the total operative duration was approximately 3 hours. Estimated intraoperative blood loss was minimal. The postoperative course was uneventful, and the patient was discharged on postoperative day 4. On the cut section, the tumor appeared tan to light brown, homogenous, and lacked areas of necrosis or cystic degeneration. Histopathological evaluation of the tumor revealed oval to spindle-shaped cells arranged in interlacing fascicles and bundles, interspersed with branching, slit-like blood vessels **(Figure 2a, 2b)**. Tumor cells exhibited mild to moderate nuclear atypia, with no evidence of mitotic activity or necrosis **(Figure 2c)**. The capsular margin was involved; however, the surgical resection margin was free of tumor infiltration. Immunohistochemically, the tumor cells were positive for Smooth Muscle Actin (SMA) and negative for HMB-45, STAT6, and CD34. These findings confirmed the diagnosis of renal angioleiomyoma **(Figure 2d)**. Postoperative follow-up consisted of clinical evaluation at 1 month, 6 months, and at 1 year, as a part of individualized institutional protocol. No new symptoms or complications were noted during follow-up. Ultrasound performed at 1 year showed no evidence of recurrence.

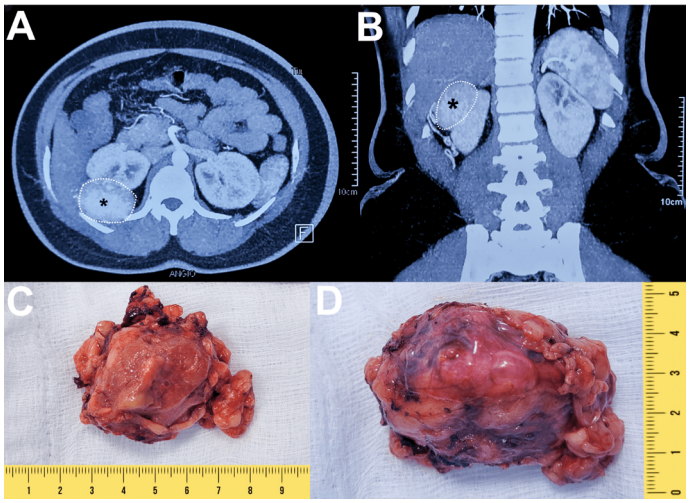

Figure 1. A,B,C,D: Cross sectional imaging & specimen
1A & 1B - Axial and Coronal sections of CECT abdomen depicting an exophytic right renal mass arising from the upper pole extending to the Perinephric fat (tumor demarcation engraved by dotted lines and epicenter marked by * mark)
1C & 1D - Resected partial nephrectomy renal mass specimen with 2-dimensional scaling measuring approximately 5x4 cm

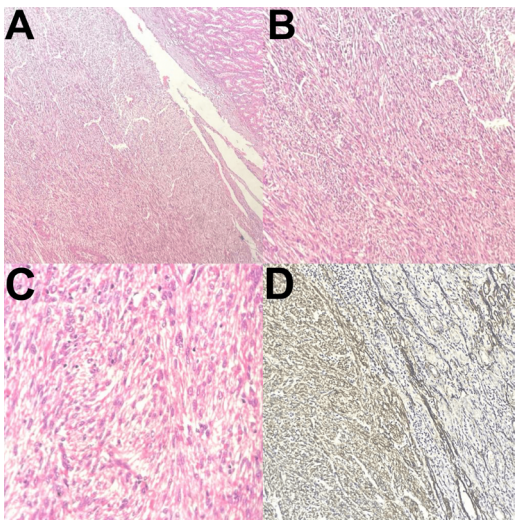

Figure 2. A,B,C,D: Tumor histology
2A - The tumor histology depicting clear demarcation from the adjacent unremarkable normal renal parenchyma, without any infiltrative edges [10x Magnification, Hematoxylin and Eosin (H&E)]
2B - The tumor is composed of interlacing fascicles of spindle cells arranged in a whorled pattern, with numerous thin, branching, slit-like blood vessels dispersed throughout the stroma (10x Magnification, H&E)
2C - Higher magnification demonstrates bland spindle cell morphology with elongated nuclei and eosinophilic cytoplasm. No atypical mitotic figures, nuclear pleomorphism, or necrosis are identified in 40X magnification
2D - Immunohistochemistry for Smooth Muscle Actin demonstrating diffuse, strong cytoplasmic positivity in tumor cells, supporting smooth muscle differentiation, with adjacent renal tubules serving as internal negative controls (10x magnification)

Discussion

Cross-sectional imaging is an indispensable part of the evaluation of renal masses. However, it often lacks sufficient specificity to reliably distinguish benign from malignant lesions, except in cases of simple renal cysts and lipid-rich angiomyolipoma (AML) [3]. Consequently, the management of renal masses is frequently guided by the presumed risk of RCC. The histopathological confirmation, therefore, remains essential for establishing an accurate diagnosis and guiding appropriate treatment planning.

Angioleiomyoma is a purely mesenchymal tumor composed of well-differentiated smooth muscle cells and thick-walled blood vessels of varying calibers. It most commonly occurs in the skin as subcutaneous nodules, whereas its development within the renal parenchyma is exceedingly rare [2]. Renal angioleiomyoma must be carefully distinguished from its more aggressive and relatively more common counterpart, RCC-AMLSt. Other important histological differential diagnoses include conventional RCC, AML, renal leiomyoma, mixed epithelial and stromal tumor, solitary fibrous tumor, and smooth muscle–predominant or adenoma-like renal tumors. RCC-AMLSt is a recently recognized entity within the spectrum of renal neoplasms. Histologically, it is characterized by a biphasic pattern, comprising areas with mixed epithelial proliferation intermingled with a prominent smooth muscle-rich stromal component. The epithelial component consists of elongated neoplastic cells arranged in sweeping fascicles within a richly vascular stroma, which often exhibits a concentric perivascular arrangement of tumor cells. Immunohistochemically, it is typically positive for carbonic anhydrase IX (CAIX), high molecular weight cytokeratin, cytokeratin 7 (CK7), and CD10, while negative for alpha-methylacyl-CoA racemase (AMACR). Notably, these tumors lack 3p25 deletions and von Hippel–Lindau (VHL) gene alterations, which are commonly seen in clear cell RCC [4-7].

While both entities share overlapping stromal features and immunohistochemical profiles, the presence of epithelial proliferation is the key distinguishing feature favoring a diagnosis of RCC-AMLSt over a benign angioleiomyoma. Given the potential for diagnostic confusion, careful correlation of histological patterns with immunohistochemical and, where available, molecular findings is crucial to avoid misdiagnosis and overtreatment. Although RCC-AMLSt is considered less aggressive than conventional RCC, it still carries malignant potential, making the distinction from angioleiomyoma clinically essential.

In a study by Williamson et al. [8], 11 patients diagnosed with RCC-AMLSt were followed for a period ranging from 26 to 58 months. All patients remained alive without evidence of residual, recurrent, or metastatic disease. Notably, one patient presented with a synchronous tumor in the contralateral kidney, which was successfully resected four months later. Conversely, Verkarre et al. reported a clinicopathological analysis of 17 patients, confirming the neoplasm's malignant potential through cases with lymph node involvement [9]. The contrasting findings underscore the diagnostic and prognostic importance of differentiating benign angioleiomyoma from malignant RCC-AMLSt. These divergent outcomes highlight the biological variability of RCC-AMLSt and the necessity for long-term follow-up in affected patients.

Among other renal tumors with overlapping histologic features, AML is an important differential diagnosis. This tumor is readily distinguishable on imaging due to the presence of macroscopic fat, which appears as areas of low attenuation ranging from -15 to -20 Hounsfield units (HU) on unenhanced CT scans. Histologically, they contain a variable mixture of smooth muscle, fat, and abnormal blood vessels. Immunohistochemical positivity for melanocytic markers such as HMB-45 and Melan-A further supports the diagnosis of AML [10]. This distinction is diagnostically significant because, unlike angioleiomyoma, they may occasionally be associated with tuberous sclerosis complex and can demonstrate aggressive growth or spontaneous hemorrhage.

Other rare mesenchymal tumors of the kidney, such as leiomyoma and smooth muscle–predominant or adenoma-like renal tumors, can also resemble angioleiomyoma. However, these entities generally lack the characteristic thick-walled vessels seen in angioleiomyoma, aiding in their distinction on histological grounds [11,12].

From a clinical standpoint, the differentiation between RCC, AML, and angioleiomyoma profoundly impacts management strategies and patient outcomes. RCC, being malignant, requires surgical resection, either partial or radical nephrectomy, followed by close surveillance for recurrence or metastasis. In contrast, AMLs, depending on their size and symptomatology, can often be managed conservatively. Small, asymptomatic AMLs are typically monitored with serial imaging, while larger or symptomatic lesions may be treated with selective arterial embolization or nephron-sparing surgery to prevent hemorrhage [13]. Renal angioleiomyoma, however, being entirely benign, does not necessitate aggressive intervention if correctly diagnosed preoperatively. Complete local excision is usually curative, and recurrence is exceptionally rare. Hence, an accurate preoperative and histopathological diagnosis is paramount to avoid unnecessary radical nephrectomy and to preserve renal function. This distinction underscores the importance of a multidisciplinary approach involving radiologists, urologists, and pathologists for accurate diagnosis and individualized patient management.

No standardized follow-up protocol currently exists for renal angioleiomyoma. Owing to its benign biological behavior, routine long-term surveillance is generally considered unnecessary once the diagnosis is confirmed. However, in cases where any diagnostic uncertainty persists, even after final histopathological evaluation, periodic follow-up imaging may be prudent to ensure timely detection of a potentially misclassified or coexisting malignant component.

Despite its indolent nature, renal angioleiomyoma represents an important histopathological diagnosis that poses a significant diagnostic challenge due to its extreme rarity and morphological similarity to RCC-AMLSt. To date, fewer than five cases have been documented in the literature. [14-15]. While numerous reports of RCC-AMLSt exist [4-9], meaningful outcome comparisons for benign angioleiomyoma remain limited because of the scarcity of reported cases and the lack of long-term follow-up data in published reports. The present case aims to contribute to the existing literature by providing insights into postoperative outcomes, follow-up considerations, and the clinical importance of distinguishing renal angioleiomyoma from RCC-AMLSt. The tumor's overlapping similarity to RCC-AMLSt, coupled with limited familiarity among clinicians and pathologists, underscores the need for careful histopathological and immunohistochemical evaluation. Accurate distinction between these entities is critical to guide appropriate clinical management and to avoid both misclassification and unnecessary aggressive treatment.

Renal angioleiomyomas are extremely rare benign tumors that closely mimic RCC-AMLSt, a neoplasm with malignant potential and comparatively poorer prognosis. Increased awareness of renal angioleiomyoma is essential for ensuring accurate diagnosis and for distinguishing it from both malignant and other benign mesenchymal renal tumors. Timely recognition can prevent overtreatment and support more tailored, conservative management when appropriate.

Ethics Committee Approval: Not Applicable.
Informed Consent: An informed consent was obtained from the patient.
Publication: The results of the study were not published in full or in part in form of abstracts.
Peer-review: Externally peer-reviewed.
Authorship Contributions: Any contribution was not made by any individual not listed as an author. Concept – S.P., Y.S; Design – S.P., Y.S.; Supervision – Y.S; Resources – P.S., H.S., S.S.; Materials – P.S., H.S., S.S.; Data Collection and/or Processing – P.S., H.S., S.S.; Analysis and/or Interpretation – V.N.K, G.S., S.S.; Literature Search – P.S., H.S.; Writing Manuscript – P.S., H.S.; Critical Review – Y.S.
Conflict of Interest: The author declares that there was no conflict of interest.
Financial Disclosure: The authors have declared that they did not receive any financial support for the realization of this study.

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Case Report – Laparoscopic and Robotic Surgery
Grand J Urol 2026;6(1):49-52
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Isthmectomy of Horseshoe Kidney During Partial Nephrectomy: A Case-based Approach

Parsiyel Nefrektomi Sırasında At Nalı Böbreğin İstmektomisi: Vaka Bazlı Bir Yaklaşım

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Abstract

Horseshoe kidneys (HSK) are the most prevalent congenital renal fusion anomalies. Its atypical anatomy with a high prevalence of vascular anomalies makes the HSK a challenging target for partial nephrectomy. Various preventive measures are to be considered before engaging in this particular surgery. In this case report, we outline our cautious surgical approach for a case of partial nephrectomy, which included an isthmectomy for safe tumour resection.

Özet

At nalı böbrekler (HSK), en yaygın doğuştan böbrek füzyon anomalilerinden biridir. Atipik anatomisi ve yüksek oranda vasküler anomali göstermesi, HSK'yı parsiyel nefrektomi için zorlu bir hedef haline getirmektedir. Bu özel ameliyata başlamadan önce çeşitli önleyici tedbirler göz önünde bulundurulmalıdır. Bu vaka raporunda, güvenli tümör rezeksiyonu için isthmektomiyi de içeren, parsiyel nefrektomi vakasına yönelik ihtiyatlı cerrahi yaklaşımımızı özetliyoruz.

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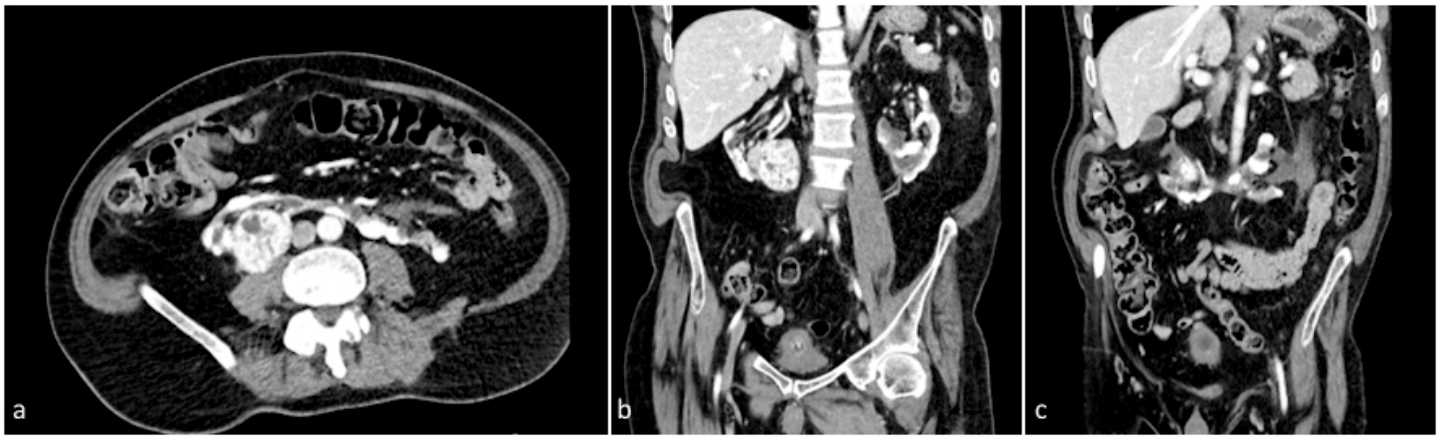

Figure 1. (a) Axial view of RCC in right moiety of the horseshoe kidney on abdominal CT, **(b)** Coronal view of RCC in right moiety of the horseshoe kidney on abdominal CT, highlighting its exophytic location, **(c)** CT enhanced coronal view on the istmus and relation to the tumour

Introduction

The horseshoe kidney (HSK) is a well-known yet insufficiently understood renal anomaly. Although higher incidences arise in men, families with renal anomalies or Turner Syndrome (14-20%), no clear genetic predisposition has been found. General incidence is around 0.15-0.45% [1,2].

During the embryogenesis horseshoe kidneys evolve from a fusion of the kidneys, most often at the lower pole (90%), connected by an isthmus consisting of functional parenchyma or fibrous tissue [1,3]. HSK could receive vascularisation from the aorta, common iliac artery, inferior and superior mesenteric artery or sacral artery. Often multiple branches are encountered for both poles and separate isthmic branches [1-3]. Venous malformations arise most often from the inferior vena cava (IVC), where double IVC, left IVC and pre-isthmic IVC are possible [1, 2]. Ureteral duplications, alternated positions in combination with different calyceal positions are often seen and could cause infections, UPJ obstruction or nephrolithiasis [1]. The diagnostic pathway for these pathologies occasionally uncovers an incidental tumour diagnosis. Tumours of the HSK are primarily renal cel carcinoma (RCC) and urothelial carcinoma, but more rare tumours like Wilms tumour and carcinoid tumour have higher incidences in HSK compared to the general population. The risk of developing urothelial cell carcinoma in HSK is four times higher, due to recurrent urinary tract infections and chronic inflammation because of stone formation and hydronephrosis [1].

Multiple treatment options exist in the management of renal cell carcinoma. The gold standard for small (< 7cm) lesions in normal shaped kidneys with chronic kidney disease remains the partial nephrectomy [4]. Robot-assisted laparoscopy is the preferred technique for performing partial nephrectomy, offering comparable oncological outcomes to open or standard laparoscopic approaches, but with a significantly lower complication rate [5]. Treatment of RCC in HSK remains to have a case-based approach, to date no guideline exists.

In this report we present the case of a robot-assisted partial nephrectomy of a solid renal mass combined with an isthmectomy while using indocyanine green (ICG) fluorescence to demarcate the isthmus.

Case

The patient was referred to our hospital after a diagnostic workup for chronic kidney disease. Ultrasound of the kidney showed an irregular mass in the lower right pole. Additional contrast enhanced CT showed a lesion measuring 55x38x51mm in the lower pole of the right kidney half of a horseshoe kidney (**Figure 1**). The lesion had a heterogenous enhancement with arterial flow. It was suspect of RCC without presence of tumor thrombus, extracapsular extent, or pathologic lymphadenopathy. Further staging with CT Thorax was negative. Baseline eGFR was 27 mL/min/1.73m2.

Vascularization showed an abnormal constitution with bilateral renal arteries, no isthmal branches, but with two accessory arteries originating from the left common iliac artery supplying the left pole.

The procedure was started in classic left lateral decubitus, with standard linear trocar placement. The Da Vinci Xi surgical robot was used with a 30-degree lens. After colon mobilization the kidney approached from the right upper pole. The renal hilum was dissected and secured with vessel loops. We started opening the Gerota fascia and followed the kidney until we found the isthmus. After placing bulldog clamps on the right renal artery, we injected ICG. Using the avascular border as demarcation we performed an isthmectomy using the monopolar scissors **(Figure 2)**. After unclamping we controlled hemostasis and continued preparing the tumor. After reclamping we started with an enucleation of the tumor. Internal renoraphy was performed using two monocryl 3-0. Early unclamping was performed followed by an external renoraphy using one hemo-lock-bolstered vicryl 3-0. Warm ischemia time was 21 minutes.

The patient left the hospital on the second postoperative day. Kidney function 1 week after surgery remained stable with an eGFR of 25 mL/min/1.73m2. The final histology report confirmed a clear cell renal cel carcinoma measuring 4.5cm with negative surgical margins and without lymphovascular invasion. Written informed consent was obtained from the patient.

Discussion

This case demonstrates a cautious approach to a potential complex partial nephrectomy. Keeping in mind that horseshoe

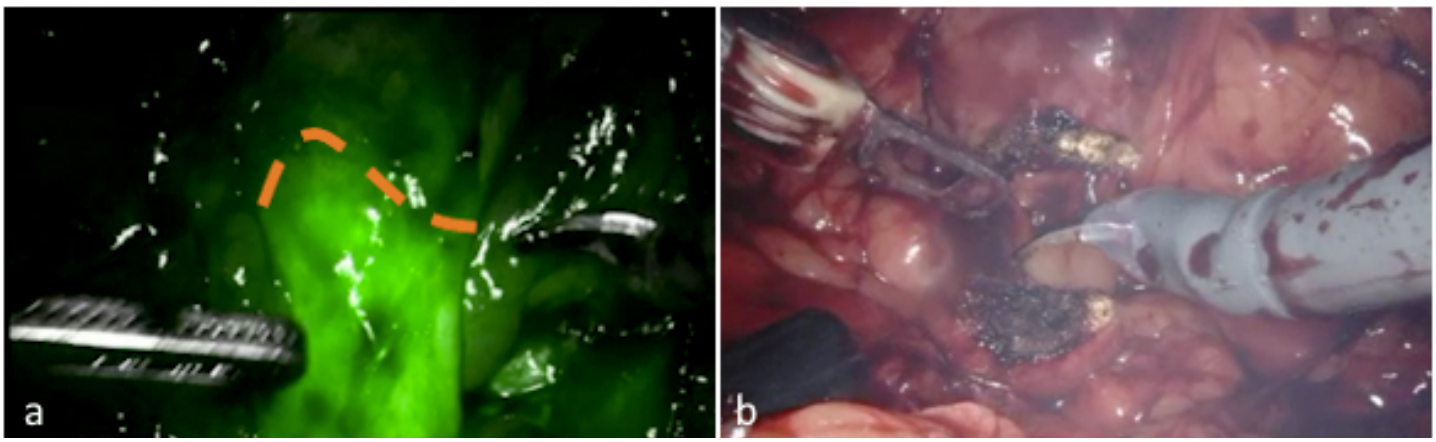

Figure 2. (a) Intra-operative view of the ICG coloration of the (non-) vascularised part of isthmus after right renal artery clamping. Orange line depicts the border of vascularisation, **(b)** Intra-operative view after isthmectomy. Right kidney moiety lays in the upper part of the picture

kidneys are difficult to mobilize, imposing an easy vascular access to a renal hilum with possible malformations making a partial nephrectomy extremely challenging. Several precautions are to be thought of before the surgery to mitigate risks and optimize outcomes.

Of utmost importance stays a high-quality contrast enhanced CT abdomen to map out the vascularisation. Vascular malformations occur in up to 95.1% of horseshoe kidneys, which imposes a great challenge while performing partial nephrectomy [6].

The aid of ICG-fluorescence during partial nephrectomy in HK is only been reported twice, yet it proves to be a useful tool [7,8]. The application of ICG gives a real-time image of active vascularisation as ICG binds serum proteins, detected by the Near-Infrared Fluorescence camera of the DaVinci system [9]. Guiding the dissection on ICG could be useful to avoid major blood loss and potential heminephrectomy. In our case, we applied ICG to perform a preventive isthmectomy. After clamping the right renal artery, we demarcated the border of the right moiety and the isthmus. If major blood loss occurred, we would have been able to safely perform a heminephrectomy, without wasting additional time on the isthmus, an additional benefit was the increased mobility of the renal moiety. We performed the isthmectomy using the monopolar scissors, as the isthmus had a small diameter and without proximity of renal calyces, as seen on the preoperative CT scan. In previous, mostly laparoscopic, reports various techniques have been reported using linear staplers, bipolar or monopolar coagulation, Ligasure or Harmonic scalpel, and even with sutures [9-13].

Newer techniques using 3D models with infield overlay of kidney, tumour, ureter and vascularisation are still under development, but have the potential to improve safety on difficult partial nephrectomies, as is the case of the horseshoe kidney [14].

Conclusion

This report describes a safe approach to partial nephrectomy in the horseshoe kidney. The use of ICG and performing an isthmectomy increases vascular control and safer tumour resection.

Ethics Committee Approval: Not Applicable.
Informed Consent: Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.
Publication: The results of the study were not published in full or in part in form of abstracts.
Peer-review: Externally peer-reviewed.
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