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Comparative Study between Ureteroscopy Using Thulium Fiber Laser (URS-TFL) and Percutaneous Nephrolithotomy (PCNL) in the Treatment of Intra-Renal Stones: A Prospective Study

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دراسة مقارنة بين تنظير الحالب باستخدام ليزر ألياف الثوليوم (*URS-TFL*) واستئصال حصى الكلى عن طريق الجلد (*PCNL*) في علاج حصى الكلى: دراسة مستقبلية

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Abstract:

Background: Renal stone disease is a common urological condition worldwide, affecting approximately 5–15% of the population and leading to significant morbidity and healthcare utilization [1]. Percutaneous nephrolithotomy (PCNL) remains the standard treatment for renal stones larger than 2 cm due to its high stone-free rate [2]. Recent technological advances have introduced the Thulium Fiber Laser (TFL), which provides efficient stone fragmentation with minimal retropulsion and improved visualization during ureteroscopy [3]. **Objective:** To compare the clinical outcomes, efficacy, and complications of ureteroscopy using Thulium Fiber Laser (URS-TFL) versus Percutaneous Nephrolithotomy (PCNL) in the management of intra-renal stones measuring 2–2.5 cm. **Methods:** This prospective comparative study included 90 patients with intra-renal stones treated at the Surgical Specialties Center, Benghazi, Libya, from January 2020 to December 2025. Patients were divided into two equal groups: 45 patients underwent URS-TFL and 45 patients underwent PCNL. Parameters evaluated included operative time, hospital stay, stone-free rate, complications, and need for redo procedures. **Results:** URS-TFL demonstrated shorter hospital stay (1–2 days) compared with PCNL (2–3 days) ($p = 0.001$). However, PCNL showed a significantly higher stone-free rate, with fewer redo procedures (6.7% vs 33.3%) ($p = 0.004$). Complications were minimal in both groups. **Conclusion:** Both URS-TFL and PCNL are safe and effective treatment options for intra-renal stones measuring 2–2.5 cm. PCNL provides superior stone clearance, whereas URS-TFL offers reduced invasiveness and shorter hospitalization.

Keywords: Renal stones, Thulium Fiber Laser, PCNL, Ureteroscopy, Lithotripsy, Kidney stones.

الملخص:

الخلفية: يُعدّ مرض حصى الكلى حالةً شائعةً في المسالك البولية على مستوى العالم، إذ يُصيب ما يقارب 5-15% من السكان، ويؤدي إلى اعتلالات كبيرة وزيادة في استخدام خدمات الرعاية الصحية [1]. ولا يزال استخراج حصى الكلى عن

طريق الجلد (PCNL) العلاج القياسي لحصى الكلى التي يزيد حجمها عن 2 سم، وذلك لارتفاع نسبة نجاحه في التخلص من الحصى [2]. وقد أدت التطورات التكنولوجية الحديثة إلى ظهور ليزر ألياف الثوليوم (TFL)، الذي يوفر تفتيتًا فعالًا للحصى مع أقل قدر من الارتداد وتحسين الرؤية أثناء تنظير الحالب [3]. **الهدف:** مقارنة النتائج السريرية والفعالية والمضاعفات لتنظير الحالب باستخدام ليزر ألياف الثوليوم (URS-TFL) مقابل استخراج حصى الكلى عن طريق الجلد (PCNL) في علاج حصى الكلى التي يتراوح حجمها بين 2 و2.5 سم. **الخلفية:** الطرق: شملت هذه الدراسة المقارنة المستقبلية 90 مريضًا مصابًا بحصى الكلى، عولجوا في مركز التخصصات الجراحية في بنغازي، ليبيا، خلال الفترة من يناير 2020 إلى ديسمبر 2025. قُسّم المرضى إلى مجموعتين متساويتين: 45 مريضًا خضعوا لتنظير الحالب عبر المنظار مع تفتيت الحصى بالمنظار (URS-TFL)، و45 مريضًا خضعوا لتفتيت الحصى عن طريق الجلد (PCNL). شملت المعايير المُقَيَّمة مدة العملية، ومدة الإقامة في المستشفى، ونسبة التخلص من الحصى، والمضاعفات، والحاجة إلى إعادة العملية. **النتائج:** أظهرت عملية تنظير الحالب عبر المنظار مع تفتيت الحصى بالمنظار (URS-TFL) مدة إقامة أقصر في المستشفى (1-2 يوم) مقارنةً بعملية تفتيت الحصى عن طريق الجلد (PCNL) (2-3 أيام) (قيمة p = 0.001). مع ذلك، أظهرت عملية تفتيت الحصى عن طريق الجلد (PCNL) نسبة أعلى بكثير في التخلص من الحصى، مع عدد أقل من عمليات إعادة العملية (6.7% مقابل 33.3%) (قيمة p = 0.004). كانت المضاعفات طفيفة في كلتا المجموعتين. **الخلاصة:** يُعد كلٌّ من تنظير الحالب بالليزر الليفي الثوليومي (URS-TFL) واستخراج الحصى عن طريق الجلد (PCNL) خيارين علاجيين آمنين وفعالين لحصى الكلى التي يتراوح حجمها بين 2 و2.5 سم. يوفر استخراج الحصى عن طريق الجلد (PCNL) إزالةً أفضل للحصى، بينما يتميز تنظير الحالب بالليزر الليفي الثوليومي (URS-TFL) بانخفاض التدخل الجراحي وقصر مدة الإقامة في المستشفى.

الكلمات المفتاحية: حصى الكلى، ليزر الألياف الثوليومي، استخراج الحصى عن طريق الجلد (PCNL)، تنظير الحالب، تفتيت الحصى، حصى الكلى.

Introduction:

Renal stone disease (urolithiasis) is one of the most common urological disorders worldwide, with an increasing incidence related to dietary habits, metabolic disorders, and lifestyle factors [1]. The prevalence of kidney stones ranges from 5% to 15% in the general population and increases with age [1].

Management of renal stones depends on stone size, location, composition, and patient-related factors [2]. Minimally invasive surgical techniques have replaced open surgery in modern urology due to improved safety and faster recovery [2]. Among these techniques, Percutaneous Nephrolithotomy (PCNL) has been established as the gold standard for treating renal stones larger than 2 cm because of its high stone-free rate and acceptable complication profile [2,4].

Recent technological advancements have introduced the Thulium Fiber Laser (TFL), which operates at a wavelength of approximately 1940 nm and allows efficient energy absorption in water, resulting in improved stone fragmentation and reduced retropulsion compared with traditional Holmium: YAG lasers [3]. Studies have demonstrated that TFL provides high ablation efficiency and improved surgical precision during ureteroscopic procedures [3,5].

Despite the increasing use of URS-TFL for renal stones, PCNL remains the preferred treatment for larger stones due to its superior clearance rate [2]. Therefore, direct comparison between these two modalities is clinically important to guide treatment selection and optimize patient outcomes.

Aim of the Study:

To compare the effectiveness, safety, and clinical outcomes of ureteroscopy using Thulium Fiber Laser (URS-TFL) versus Percutaneous Nephrolithotomy (PCNL) in patients with intra-renal stones measuring 2–2.5 cm.

Patients and Methods:

Study Design and Setting:

This was a prospective comparative study conducted at the Surgical Specialties Center, Benghazi, Libya, from January 2020 to December 2025.

Study Population:

A total of 90 patients with intra-renal stones were included in the study. The study population consisted of 60 males and 30 females, with an age range of 22 to 63 years.

Patients were equally divided into two groups:

- **Group A**: 45 patients underwent ureteroscopy using Thulium Fiber Laser (URS-TFL)
- **Group B:** 45 patients underwent Percutaneous Nephrolithotomy (PCNL)

All stones were located within the renal collecting system (intra-renal stones) and measured between **2 cm** and **2.5 cm** on non-contrast computed tomography (NCCT).

Type of Anesthesia:

All procedures were performed under general anesthesia according to standard anesthetic protocols [2].

Ureteral Stenting:

- In the URS-TFL group, preoperative double-J (DJ) stenting was performed in 30 patients, and postoperative DJ stenting was inserted in 27 patients.
- In the PCNL group, preoperative DJ stenting was performed in 10 patients, while postoperative antegrade DJ stenting was required in 5 patients.

Inclusion Criteria:

- Patients aged 18–70 years.
- Presence of intra-renal stone confirmed by CT scan.
- Stone size between 2 cm and 2.5 cm.
- Fit for general anesthesia.
- Consent to participate in the study.

Exclusion Criteria:

- Patients with bleeding disorders.
- Pregnancy.
- Active urinary tract infection.
- Severe renal impairment.
- Anatomical abnormalities of the urinary tract.
- Patients with solitary kidney.

Preoperative Evaluation:

All patients underwent the following assessments according to standard urological guidelines [2]:

- Detailed medical history and clinical examination.
- Urinalysis and urine culture.
- Complete blood count (CBC).
- Serum creatinine and blood urea.
- Coagulation profile.
- Ultrasound of the urinary tract.
- Non-contrast CT scan (NCCT).

Outcome Measures:

The following parameters were evaluated:

- Operative time (minutes).
- Hospital stays (days).
- Stone-free rate (%).
- Postoperative complications.
- Need for blood transfusion.
- Need for redo or second procedure.

Follow-Up Schedule:

Patients were followed according to the following schedule:

Time Point	Assessment
Day 1 post-operation	Clinical examination and laboratory tests
At discharge	Ultrasound evaluation
4 weeks	Ultrasound or CT scan
12 weeks	Final assessment of stone clearance

Statistical Analysis:

Data were analyzed using “Statistical Package” for the Social Sciences (SPSS) version 26. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as numbers and percentages. The Chi-square test was used for categorical variables, and the student t-test was used for continuous variables. Statistical significance was considered at $p < 0.05$ [6]. For variables initially reported as ranges, the mean and standard deviation were estimated using the midpoint and range/4 method as described by Hozo et al. [7].

Results:

Table (1): Demographic Characteristics of Patients

Variable	URS-TFL (n=45)	PCNL (n=45)	p-value
Male/Female	30 / 15	30 / 15	0.91
Age range (years)	22–63	22–63	0.88
Stone size (cm)	2–2.5	2–2.5	0.95
Stone location	Intra-renal	Intra-renal	1.00

Table 1. demonstrates the total number of male and female, age group, stone size and stone location.

Table (2): Operative and Clinical Outcomes

Parameter	URS-TFL (n=45)	PCNL (n=45)	p-value
Operative time (minutes)	67.5 ± 11.25	52.5 ± 3.75	0.03
Hospital stays (days)	1.5 ± 0.25	2.5 ± 0.25	0.001
Redo / Second procedure	15 (33.3%)	3 (6.7%)	0.004

Table 2. shows the average operative time for each operation, hospital stay for each operation and the need for second operation for stone.

Table (3): Postoperative Complications

Complication	URS-TFL (n=45)	PCNL (n=45)	p-value
Fever	1 (2.2%)	0	0.31
Urinary tract infection	5 (11.1%)	0	0.02
Bleeding	0	(2.2%)	0.31
Blood transfusion	0	(2.2%)	0.31

Table 3. demonstrates the complications that occurred for each operation that includes; fever, urinary tract infection, bleeding and the need for blood transfusion.

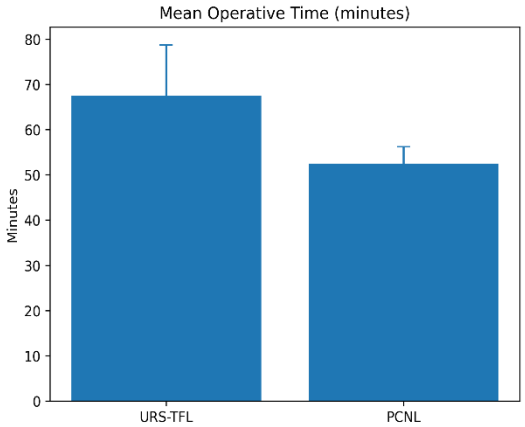

Figure (1): Comparison of mean operative time between URS-TFL and PCNL groups. Error bars represent standard deviation (Mean ± SD).

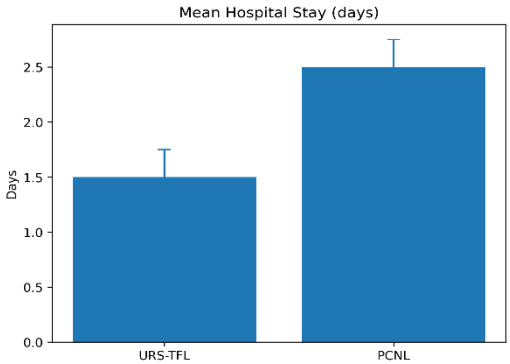

Figure (2): Comparison of mean hospital stay between URS-TFL and PCNL groups. Error bars represent standard deviation (Mean ± SD).

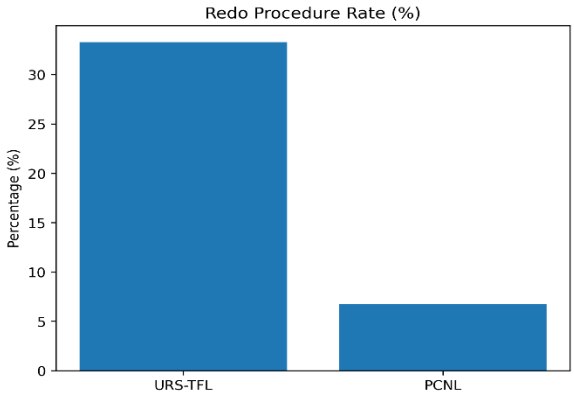

Figure (3): Comparison of redo procedure rate between URS-TFL and PCNL groups.

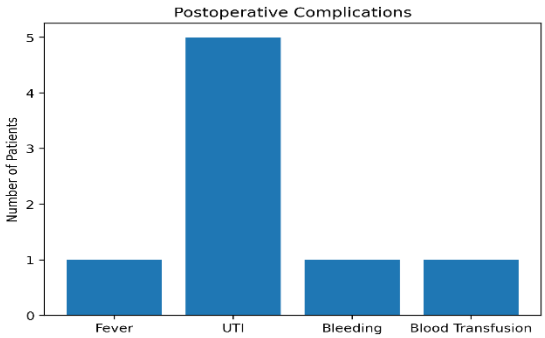

Figure (4): Distribution of postoperative complications in the study population.

Discussion:

Percutaneous nephrolithotomy (PCNL) has long been considered the gold standard treatment for renal stones larger than 2 cm due to its high stone-free rate and reliable clinical outcomes. International guidelines from the European Association of Urology (EAU) and the American Urological Association (AUA) consistently recommend PCNL as the first-line treatment for large renal calculi because of its superior efficacy compared with other minimally invasive techniques **[1, 2]**.

In the present study, PCNL demonstrated a significantly lower need for redo procedures compared with ureteroscopy using Thulium Fiber Laser (URS-TFL) (6.7% vs. 33.3%, p = 0.004), indicating a higher stone clearance efficiency in patients with intra-renal stones measuring 2–2.5 cm. This finding is consistent with previous clinical studies reporting higher stone-free rates with PCNL for stones larger than 2 cm **[2, 6]**.

The higher stone clearance observed in the PCNL group in this study can be explained by the direct access to the renal collecting system, which allows removal of large stone fragments in a single session. Zeng et al. reported stone-free rates exceeding 90% with PCNL for renal stones measuring 2–3 cm, significantly higher than ureteroscopic approaches **[6]**. These findings support the continued role of PCNL as the standard treatment modality for large renal stones.

Despite the superior stone clearance achieved with PCNL, ureteroscopy using Thulium Fiber Laser has gained increasing attention due to its minimally invasive nature and favorable safety profile. The Thulium Fiber Laser operates at a wavelength of approximately 1940 nm, which provides improved energy absorption in water and more efficient stone fragmentation compared with conventional Holmium:YAG lasers **[3]**. This technological advantage contributes to reduced retropulsion and improved visualization during ureteroscopic procedures **[3, 5]**.

In the present study, patients treated with URS-TFL had a significantly shorter hospital stay compared with those treated with PCNL (mean 1.5 vs. 2.5 days, p = 0.001). This finding is consistent with previous reports demonstrating faster postoperative recovery and shorter hospitalization following ureteroscopic procedures **[5]**. Shorter hospital stay represents an important clinical advantage, particularly in healthcare systems with limited hospital resources.

Operative time in this study was significantly longer in the URS-TFL group compared with the PCNL group (67.5 ± 11.25 minutes vs. 52.5 ± 3.75 minutes, p = 0.03). This difference may be attributed to the need for gradual fragmentation of stones into small particles during ureteroscopy, whereas PCNL allows direct extraction of larger fragments through a percutaneous tract. Similar findings have been reported in previous comparative studies evaluating flexible ureteroscopy and PCNL for renal stones **[6]**.

Postoperative complications in both treatment groups were relatively low in the present study, confirming the safety of modern endourological techniques. Urinary tract infection occurred in 11.1% of patients in the URS-TFL group, while bleeding requiring blood transfusion occurred in one patient (2.2%) in the PCNL group. These complication rates are comparable to those reported in the literature, where infection is the most common complication following ureteroscopy and bleeding is the most significant complication associated with PCNL **[4, 6]**.

An important strength of the present study is its prospective design and direct comparison between two widely used treatment modalities. The equal distribution of patients between the URS-TFL and PCNL groups and the standardized follow-up schedule enhanced the reliability of the outcome measurements.

However, several limitations should be considered when interpreting the results of this study. First, the sample size was relatively small, which may limit the generalizability of the findings. Second, the study was conducted at a single center. Third, long-term follow-up beyond 12 weeks was not performed, which may underestimate the rate of late complications or stone recurrence. Future multicenter studies with longer follow-up periods are recommended to validate these findings.

Overall, the findings of the present study support the continued role of PCNL as the definitive treatment for renal stones measuring 2–2.5 cm due to its superior stone clearance and lower need for repeat procedures, while URS-TFL remains a safe and minimally invasive alternative in selected patients.

Conclusion:

Both ureteroscopy using Thulium Fiber Laser (URS-TFL) and Percutaneous Nephrolithotomy (PCNL) are safe and effective treatment modalities for intra-renal stones measuring 2–2.5 cm. PCNL demonstrated a higher stone-free rate with fewer redo procedures, whereas URS-TFL provided shorter hospital stay and lower invasiveness. Proper patient selection is essential to optimize treatment outcomes.

Ethical Approval:

This study was conducted in accordance with the ethical standards of the institutional and national research committee and with the principles of the Declaration of Helsinki. Ethical approval for the study was obtained from the local ethics committee of the Surgical Specialties Center, Benghazi, Libya.

Informed Consent: Written informed consent was obtained from all patients prior to inclusion in the study.

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Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Abbreviations:

- **URS:** Ureteroscopy
- **TFL:** Thulium Fiber Laser
- **PCNL:** Percutaneous Nephrolithotomy
- **DJ:** Double-J stent
- **NCCT:** Non-contrast computed tomography
- **SPSS:** Statistical Package for the Social Sciences

References (Vancouver Style):

1. Türk C, Neisius A, Petrik A, et al. EAU Guidelines on Urolithiasis. European Association of Urology. 2024.
2. Assimos D, Krambeck A, Miller NL, et al. Surgical management of stones: AUA/Endourology Society guideline. Journal of Urology. 2016.
3. Traxer O, Keller EX. Thulium fiber laser: the new player for kidney stone treatment. World Journal of Urology. 2020.
4. Fernström I, Johansson B. Percutaneous pyelolithotomy. Scandinavian Journal of Urology and Nephrology. 1976.
5. Enikeev D, Taratkin M, Klimov R, et al. Thulium fiber laser for kidney stone treatment: A systematic review. Journal of Endourology. 2021.
6. Zeng G, Zhao Z, Wan S, et al. Super-mini percutaneous nephrolithotomy vs flexible ureteroscopy for renal stones 2–3 cm: A prospective randomized study. European Urology. 2018.
7. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and size of a sample. BMC Medical Research Methodology. 2005.