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Original Article

Holmium Laser Lithotripsy for Urinary Calculi: A Retrospective Analysis from a Tertiary Hospital in Abuja, Nigeria

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Abstract

Background: Over the last decade, Holmium: YAG (Ho: YAG) laser has emerged as the gold standard for the intracorporeal treatment of urinary tract calculi. However, this technology is not readily available in most public-owned hospitals in Nigeria. This study aims to retrospectively document our experience with the efficacy and safety of Ho: YAG laser lithotripsy for urinary calculi at the Federal Medical Centre, Abuja.

Methodology: We reviewed all patients who underwent laser lithotripsy at FMC Abuja from April 2021 to October 2025. We deployed 600 µm, 365 µm, and 272 µm fibers with power settings of 50W, 10W, and 20W, respectively, for the lithotripsy of bladder, ureteral, and renal stones. Data recorded include the size, density, location of the stone, and clinical presentations and outcomes.

Results: A total of 111 patients underwent laser lithotripsy during the study period. Ages ranged from 18 to 67 years, with a mean age of 40.28 ± 12.3 years. The male-to-female ratio was 2:1. Of the patients, 45 (40.5%) had ureteral stones, 38 (34.2%) had renal stones, 17 (15.3%) had bladder stones, and 8 (7.2%) presented with calculi in both the kidney and ureter. Flank pain was the most common presentation (n = 62, 55.9%). Right-sided stones were predominant (n=49, 44.1%), while 18 (16.2%) had bilateral stones. The mean stone density was 968.68 HU (range: 566 - 1502). The mean post-operative hospital stay was 2.61 ± 1.34 days, with a stone clearance rate of 90.1%. Postoperative complications included fever (n=16, 14.4%), stent pain (n =3, 2.7%), and ureteric perforation (n=1, 0.01%).

Conclusion: The Holmium laser is a safe and effective modality for lithotripsy in our setting, associated with minimal postoperative complications. Further data will be necessary to substantiate this conclusion.

Keywords: Holmium laser, Lithotripsy, Urolithiasis, Kidney, Ureter

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Introduction

Urinary calculi, stones in the kidneys, ureters, bladder, or urethra [1,2], have posed a significant health challenge worldwide, affecting millions of individuals annually. The incidence of urolithiasis has been increasing [3], with epidemiological data indicating that it affects approximately 10-15% of the population during their lifetime, and a higher prevalence is noted in males [4,5]. Various risk factors, including age, dietary habits, dehydration, and metabolic disorders, contribute to the formation of these calculi, leading to significant morbidity and increased healthcare costs [6-11].

Over the last decade, laser lithotripsy, particularly utilizing the Holmium: YAG laser, has emerged as a remarkable advancement in the management of urolithiasis [12 -14]. This technology offers a minimally invasive approach to fragmenting stones in various organs such as kidneys, ureters, and bladder, demonstrating efficacy and safety as it minimizes damage to the surrounding tissue. Thus, low complication rate, less post-operative pain, and short hospital stay [15,16].

The Holmium laser is considered the gold standard for ureterorenoscopic lithotripsy due to its versatility in fragmenting all types of urinary calculi [14,17,18]. It operates by delivering pulsed energy that causes rapid vaporization of water within the stone, generating acoustic shockwaves and cavitation bubbles that lead to stone fragmentation [15,19]. This mechanism allows for effective stone disintegration with minimal retropulsion [20]. Power settings for the Holmium: YAG laser typically vary, influencing the fragmentation efficiency [21].

In Nigeria, the adoption of laser lithotripsy is increasingly reported, reflecting a shift from the traditional open surgeries to less invasive procedures for the treatment of stone disease [7,12,13]. However, data on the efficacy and safety of Ho: YAG laser lithotripsy in the Nigerian context remain limited. Thus, this study aims to retrospectively document our experience with the Ho: YAG laser for urinary calculi treatment, focusing on efficacy, safety, and patient outcomes at a tertiary hospital in Abuja.

Patients and Methods

In this retrospective study, we reviewed the outcomes of all patients who underwent laser lithotripsy for stone management at Federal Medical Centre, Abuja, between April 2021 and October 2025.

Preoperatively, all patients had imaging studies, including urologic ultrasounds and/or computed tomography urography (CTU) scans, to accurately determine the size, density, and location of the stones. The stone density was quantified using Hounsfield units (HU) derived from CT scans, which provided insights into the composition of the stones and their resistance to fragmentation. These evaluations were in addition to full blood count, urinalysis, urine microscopy/culture/sensitivity, and kidney function test. They also had chest X-rays and electrocardiography when indicated.

For the lithotripsy procedures, we utilized three different sizes of laser fibers: 600 micrometers (µm), 365 µm, and 272 µm. The selection of fiber size depended on the specific clinical scenario and the location of the stones being treated. The corresponding power settings for our 100Watts Quanta laser were tailored as follows: 50 watts for bladder stones, 20 watts for renal stones, and 10 watts for ureteral stones. The bladder, lower ureter, mid and upper ureter, and kidney were accessed through a cystoscope, semi-rigid ureteroscope, and flexible ureterorenoscope, respectively.

The respective anatomic parts of the urinary tract were inspected at the end of the procedure. Severity of ureteric injuries was endoscopically graded based on Traxer classification as follows: Grade 0 (No injury), Grade 1 (mucosal petechiae or partial thickness laceration), Grade 2 (laceration involving muscular layer with extravasation), Grade 3(full thickness laceration), and Grade 4 (Ureteral avulsion). We routinely passed a Double-J (DJ) stent after the procedure, which was removed at 3 weeks.

Postoperatively, patients were monitored for complications, defined according to the Clavien-Dindo classification, and for stone-free rates (SFR), assessed through follow-up imaging, which we performed at 4-6 weeks post-procedure. SFR connotes the absence of stone in the urinary tract on abdomino-pelvic ultrasound or stone < 4mm on CTU. Additionally, we recorded overall clinical outcomes, including pain scores, recovery time, and the need for secondary interventions.

Patients with calculi greater than 20mm were excluded from this study.

The Health Research and Ethics Committee of the institution approved the study protocol (**FMCABJ/HREC/2025/301**).

Data were obtained from the hospital's electronic medical record (EMR) and operating theatre register using a proforma that included patients' demographics, clinical presentation, stone characteristics, laser settings/fibre sizes deployed, duration of surgery, and surgical outcomes. This was analysed using the Statistical Package for Social Sciences (SPSS) version 22.

Results:

A total of 111 patients underwent laser lithotripsy within the study period. The age of the patients ranged from 18 to 67 years, with a mean age of 40.28 years (± 12.3 years). The cohort exhibited a male-to-female ratio of 2:1, indicating a higher prevalence of urinary stones in males.

Upon analysis of the stone types, it was observed that 45 patients (40.5%) presented with ureteral stones, 38 (34.2%) had renal stones, 17 (15.3%) had bladder stones, and 11 patients (10%) exhibited calculi located in both the kidney and ureter, as depicted in Table 1.

Table 1: Sites of stone in the urinary tract

Location of the stone	N=111	%
Kidney only	38	34.2
Ureter only	45	40.5
Bladder	17	15.3
Kidney and ureter	11	10

The most common presenting symptom among the patients was flank pain, reported by 62 patients (55.9%) (Figure 1). Additionally, the distribution of stone laterality revealed a predominance of right-sided stones, observed in 49 cases (44.1%), while 18 patients (16.2%) had bilateral stones.

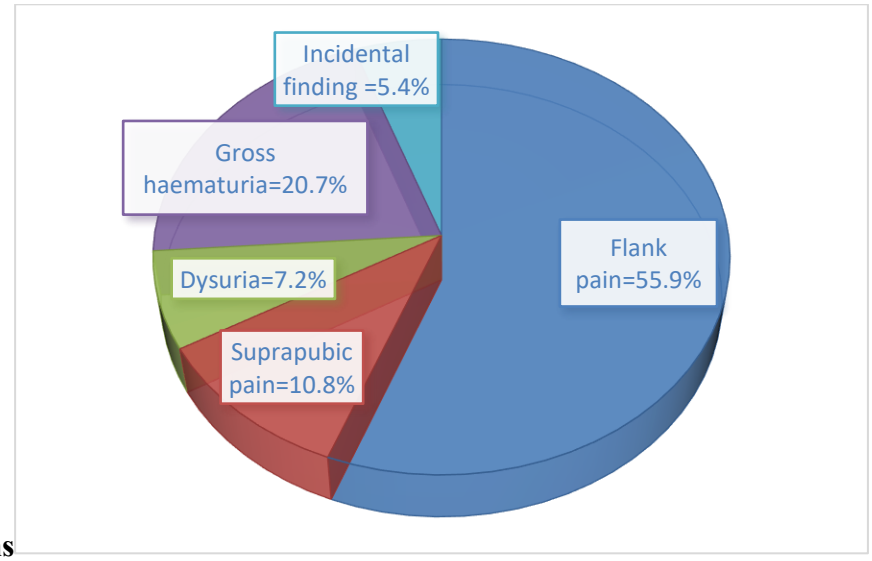


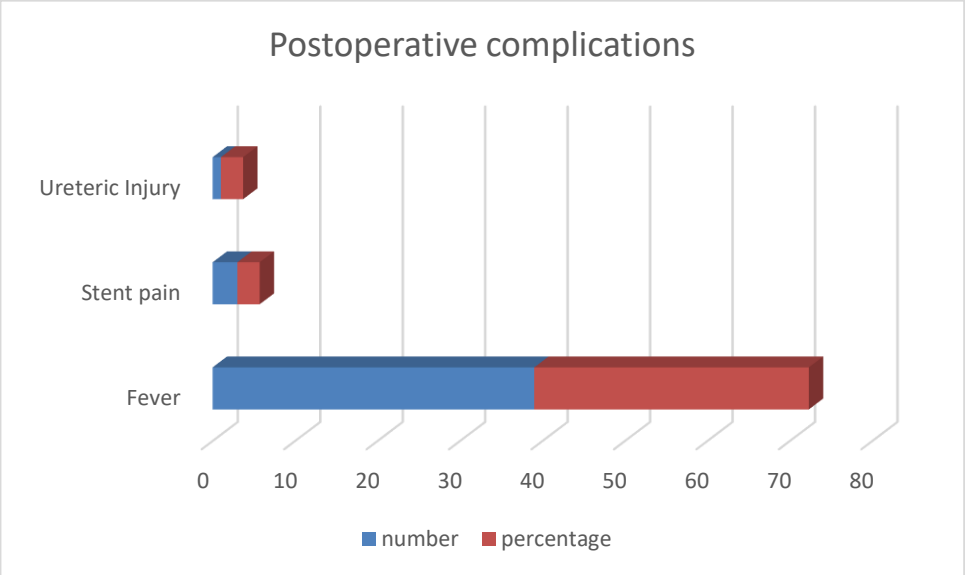
Figure 1: Presenting symptoms

The mean stone density measured was 968.68 Hounsfield Units (HU), with a range from 566 to 1502 HU, indicating varied composition and density of the calculi among the patient population.

The mean duration of postoperative hospital stay was 2.61 ± 1.34 days with a range of 1-5 days, suggesting effective recovery and management protocols. The stone clearance rate achieved was 90.1%.

Postoperative complications were documented (Figure 2), with fever occurring in 16 patients (14.4%), stent pain (n=3, 2.7%), and a single case of ureteric perforation (0.01%).

Figure 2: Postoperative complications



Discussion:

Laser lithotripsy remains a pivotal technique in managing urolithiasis, demonstrating significant efficacy and safety [12-14]. In our study involving 111 patients, we evaluated the demographic characteristics, stone types, clinical presentations, surgical outcomes, and complications associated with this procedure, contributing valuable insights to the existing body of literature.

The mean age of the patients was 40.28 years, aligning with previous studies and indicating a higher incidence of urinary stones in middle-aged populations [10, 22, 23]. The predominance of male patients (male-to-female ratio of 2:1) further corroborates findings by the National Institutes of Health, which reports that men are more likely to develop urinary stones than women [24,25].

Pain is often the hallmark symptom in patients with urolithiasis, and our findings reflect this, with flank pain reported by 55.9% of patients. This symptomatology is consistent with the literature, indicating that obstructive stones typically cause significant discomfort, which may be associated with nausea or vomiting [26,27].

The stone location and composition are critical for determining the appropriate treatment approach. Our series observed that ureteral stones (40.5%) were the most common, followed by renal (34.2%), bladder (15.3%), and both kidney and ureter (7.2%). This distribution is similar to other studies, indicating that ureteral stones are frequently the cause of acute flank pain due to their obstructive nature [28]. Moreover, the mean stone density of 968.68 HU found in our cohort aligns with established correlations between stone density and treatment success, suggesting that denser stones may require a more aggressive intervention [29].

One of the most notable findings in our study was the stone clearance rate of 90.1%, which is in agreement with reported rates of 87% to 98% for laser lithotripsy [30-32]. This high efficacy underscores the effectiveness of laser lithotripsy as a first-line treatment for urolithiasis, particularly for ureteral stones. Out of 11 patients who had residual stones, 9 were re-operated on, while the remaining two patients had percutaneous nephrolithotomy at another facility.

In terms of postoperative outcomes, the mean hospital stay was 2.61 ± 1.34 days with a range of 1-5 days, which reflects advances in surgical techniques and perioperative management, allowing for expedited recovery. This finding is also documented by Yan et al [33,34]. However, some complications were noted in our study, with fever observed in 14.4% of patients, stent pain (2.7%), and ureteric perforation in 0.01%. While postoperative fever is not uncommon and often resolves with conservative management, the occurrence of ureteric perforation necessitates careful patient selection and surgical technique to minimize risks [35]. Some researchers have reported an overall complication rate of 4.7 - 9% [36, 37] with ureteric perforation of less than 2% [38]. Our relatively high post-operative fever, compared to other studies [39, 40], may be due to bacterial/endotoxic release from the fragmented calculi, tissue trauma, or urinary extravasation [41]. Expectedly, all the patients recovered with antibiotics. The only ureteric perforation was a grade 2 injury according to the Traxer classification system [42]. This was managed with DJ stenting.

Conclusion:

Our study reinforces the effectiveness of laser lithotripsy in treating urolithiasis, showcasing a high stone clearance rate, patient safety, and manageable postoperative complications. Further data will be desirable to substantiate this conclusion.

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