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| **RESEARCH ARTICLE**

Lithotripsy in the Kidneys Ureters and Bladder Using A Laser

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| ABSTRACT

In this research paper, we address an important aspect of human health: urinary stones and non-surgical urinary stone fragmentation using laser technology. Urinary stones are a worrisome disease due to their widespread prevalence and numerous complications, which cause multiple symptoms, including severe pain, urinary tract obstruction, and recurrent infections. Recently, due to the limitations of traditional surgical methods, the medical field has opened up to laser-based surgery, specifically laser lithotripsy, as an alternative characterized by high precision and less invasive surgery. We will discuss the role of laser technology in fragmenting urinary stones (kidney, ureter, and bladder), the mechanism of stone formation, their classification according to their components, and diagnostic methods. We will also discuss the types of lasers used in lithotripsy, particularly the Nd:YAG laser, the Ho:YAG laser, and the thulium fiber laser (TFL). We will explain the mechanism of stone interaction with the laser, specifically the photothermal and photomechanical effects, the laser settings specific to each part of the urinary tract in terms of power and frequency parameters, and the appropriate laser selection. This research paper contributes to the evidence supporting the efficacy and safety of laser lithotripsy in urology.

| KEYWORDS

Lithotripsy, human health, laser, kidney, ureter.

| ARTICLE INFORMATION

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1. Introduction

Stones are solid objects or deposits composed of minerals and salts that accumulate in the urine. They are one of the most common urinary tract diseases worldwide. Patients with stones experience several symptoms, including severe pain in the flank or abdomen, blood in the urine, difficulty urinating, nausea, vomiting, cloudy urine, and in some cases, abdominal swelling. They are a source of discomfort and negatively impact the patient's quality of life. They represent a significant challenge due to their severe pain and numerous potential complications, as well as their recurrence. The recurrence rate of urinary tract stones is 7% within one year and 50% within 10 years [1]. Despite the development of successful treatments in the field of urology, the high rate of recurrence makes them a health problem that requires improved methods to achieve long-term results [2]. This has necessitated the development of new, more effective, and less invasive treatment methods, replacing traditional methods. Laser lithotripsy has emerged, characterized by its high flexibility and effectiveness in the urinary tract. The neodymium-doped yttrium aluminum garnet (Nd:YAG) laser is one of the first lasers used in this field, operating at a wavelength of 1064 nm [3]. It generates high-energy pulses that fragment stones by emitting shock waves focused on the surface of the stone, effectively fragmenting the internal stones without the need for surgical incisions [4]. The physical mechanism of laser lithotripsy relies on the photothermal effects of the laser. The intense thermal energy generated by the laser creates tiny cracks in the stone structure, facilitating the process of fragmenting or fragmenting them into small stones that can be eliminated naturally [5]. When fragmenting stones with a laser, the physician can control and modify three elements to achieve the desired effect: first, the pulse energy (joules), second, the pulse frequency (hertz), and third, the pulse duration (microseconds) [6]. Thermal damage occurs as a result of the photothermal interaction of the laser with the stones, as the surrounding tissue absorbs the thermal energy emitted during treatment, leading to damage to the adjacent tissue [7].

1.1 Urinary Tract Stone Formation: Causes and Diagnosis

Urinary stones are defined as solid deposits and masses composed of minerals and salts that coalesce or crystallize to form stones. This condition affects the urinary system as a whole and is one of the most common disorders. The causes of stone formation vary, ranging from dehydration, which leads to decreased urine volume and increased salt excretion, to metabolic disorders such as hypercalciuria or hyperoxaluria, or chronic urinary tract infections.

Main Factors Influencing Urinary Tract Stone Formation: Many factors influence the formation of stones in a person. A major factor is inadequate fluid intake, which leads to increased urine concentration and an increased risk of mineral deposition. Genetic predisposition plays a significant role, as inherited metabolic traits can influence urine composition. Dietary habits—particularly high sodium or animal protein intake—can increase urinary calcium excretion or alter the acid-base balance, promoting stone formation. Certain medications may also predispose to stone formation, either by directly crystallizing in the urine or by altering the urinary environment [8].In addition to the balance of stone-forming and stone-dissolving substances, urine pH is a crucial factor: most types of stones form if the urine is too acidic. However, stones can also form if urine becomes less acidic and more alkaline, for example, during a urinary tract infection. Most uric acid and cystine stones form in acidic urine, while struvite stones are more likely to form in alkaline conditions often associated with infection [9]. Thus, both the chemical composition of urine and its pH play a key role in determining the type of stone and the likelihood of its formation.

1.2 Types of stones in the urinary system

Urinary tract stones are generally classified into five main types, each characterized by its chemical composition and clinical features.

1- Calcium stones: Calcium-containing stones are the most common, accounting for approximately 80% of all urinary tract stones [10]. These stones typically consist of calcium oxalate (CaOx), calcium phosphate (CaP), or a combination of both. Pure calcium oxalate stones account for approximately 50% of cases, calcium phosphate stones account for approximately 5%, and a combination of both. Oxalate, a natural compound produced in the liver or absorbed from dietary sources such as leafy greens, nuts, and chocolate, plays a pivotal role in stone formation. Contributing factors include metabolic disorders such as hyperoxaluria, hyperuricemia, hypocitrateuria, hypomagnesemia, and hypercystinuria.

2- struvite stones or magnesium-ammonium phosphate stones: Also known as infection stones, urease-producing struvite stones, or triphosphate stones, they typically occur in patients with recurrent or chronic urinary tract infections [11]. Urea is broken down into ammonia and carbon dioxide, and these stones form as a result of the breakdown of urea into ammonia and carbon dioxide, which increases the alkalinity of the urine and raises the pH above 7. Struvite stones can enlarge rapidly and may reach a large size, and sometimes symptoms are mild or absent, posing a risk.

3- Uric acid stones or urate stones: These stones result from low urine pH (pH < 5.05), low urine volume, and elevated uric acid levels—often due to a diet rich in purines found in meat, fish, and other animal products [12]. In addition to dietary causes, people with chronic diarrhea or malabsorption syndromes are at increased risk due to persistent fluid loss and altered nutrient absorption. These conditions reduce urine volume and acidity, creating favorable conditions for uric acid crystallization.

4- Cystine stones: Cystine stones are relatively rare and have a genetic basis. They occur due to a genetic defect that affects cystine reabsorption in the proximal renal tubules. As a result, the genetic defect can cause cystine to leak from the kidneys or be improperly reabsorbed. This leads to cystine accumulation and stone formation due to its insoluble nature in urine, where its low solubility promotes crystal formation and stone formation [13]. Cystinuria typically leads to recurrent stone episodes beginning in childhood or early adulthood.

5- Drug-induced stones: Approximately 2% of urinary stones are associated with medication. These stones arise either from the medication or its metabolites, which are deposited directly in the urine, or indirectly through drug-induced chemical changes in the urine that contribute to stone formation [14]. Some medications can reduce the solubility of urine or increase the excretion of stone-forming substances in the urine, contributing to the formation of calcium or uric acid stones.

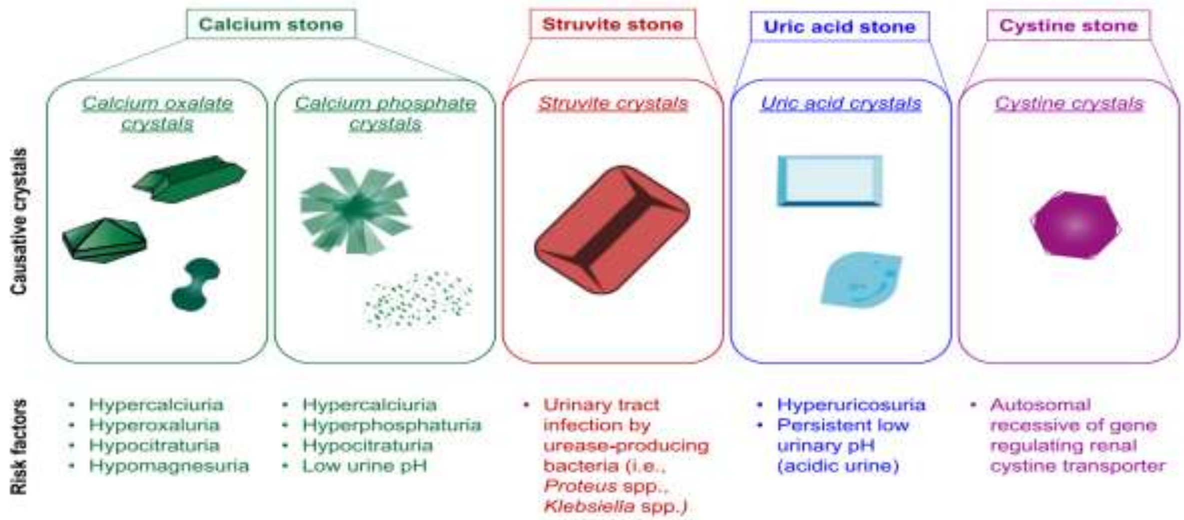

Figure (1): The types of kidney stones were classified based on their crystalline composition, and their risk factors [15].

1.3 Locations of Stones

Stones can develop anywhere within the urinary system, which plays a crucial role in the body's metabolic regulation. This system handles numerous metabolic processes across various cells, leading to the production of a wide range of waste products. The urinary system eliminates these wastes by filtering and purifying the blood through the kidneys. Additionally, it helps regulate the volume, pH, salinity, concentration, and composition of bodily fluids, including blood and lymph. As a result of these functions, urine is formed—a fluid composed primarily of water and metabolic waste.The urinary system is composed of the kidneys, ureters, and bladder [16]. Urinary tract stones, which are solid crystalline deposits, are a common clinical problem. These stones can form in any part of the urinary tract, including the kidneys, ureters, bladder, or even the urethra.

1. Kidney Stones: Renal calculi typically begin forming in the renal calyces or pelvis due to concentrated urine and super saturation with lithogenic substances. They may remain silent for extended periods and are often discovered incidentally unless they dislodge and cause obstruction or pain.

2. Ureteral Stones: When a stone migrates into the ureter, it can obstruct urine flow from the kidney to the bladder. This results in acute, often severe pain known as renal colic, commonly radiating from the flank to the groin. Ureteral stones may also cause hematuria, nausea, or vomiting, depending on the degree of obstruction.

3. Bladder Stones: Stones that reach the bladder but fail to exit the body may enlarge over time, particularly in individuals with urinary retention, bladder outlet obstruction, or chronic infection. Bladder stones are often associated with recurrent urinary tract infections, urinary frequency, and discomfort during voiding

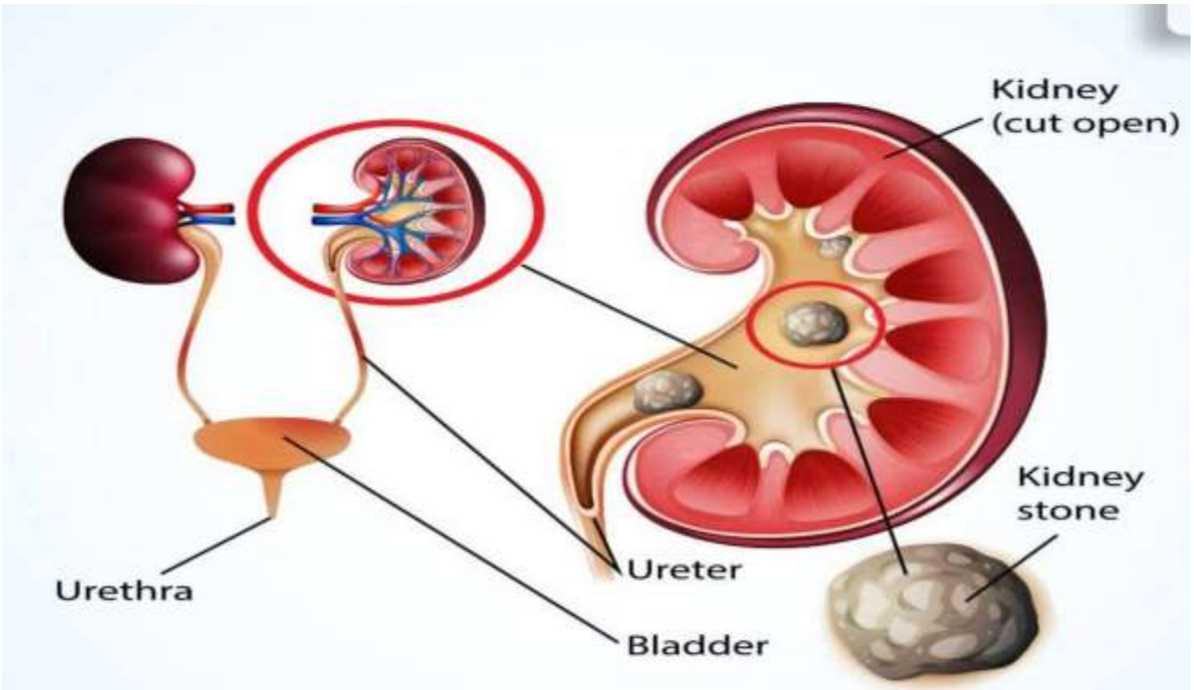

Figure (2): the urinary system [17].

1.4 Investigations and Diagnosis

When evaluating a patient with suspected urinary stones, a comprehensive diagnostic approach is essential. The following tests are typically used during the initial evaluation:

1. Urinalysis (UA): Microscopic analysis may reveal blood in the urine or microscopic traces of blood. The presence of leukocyte esterase (LE), nitrite, and white blood cells may indicate a urinary tract infection (UTI). Urinalysis also provides information about urine pH and the presence of bacteria. If nitrite, leukocytes, or bacteria are detected, a urine culture should be performed and appropriate treatment initiated [18].

2. Blood Tests: A complete blood count (CBC) and comprehensive metabolic panel (CMP) can assess electrolyte levels, including calcium and uric acid. Additional parameters such as creatinine, amylase, lipase, and lactic acid may also be tested to assess kidney function and detect any impact of stones on kidney function [18].

3. KUB X-ray : This imaging technique is useful for identifying large, radiopaque stones, especially those composed of calcium. However, its sensitivity is limited for detecting smaller stones or radiolucent stones such as those composed of uric acid or cystine [19].

4. Ultrasound: This non-invasive, radiation-free imaging tool is preferred for children and pregnant women. It effectively detects stones in the kidneys and bladder, especially those located at the junction between the ureter and renal pelvis. While it can image stones larger than 4 mm, its sensitivity is lower for stones smaller than 5 mm or those located in the ureter [20].

5. Non-contrast computed tomography (CT): This imaging technique is the most accurate for detecting urinary stones. It can identify even small, non-calcified stones and accurately locate them, including within the ureters. CT scans are often used when patients present with severe abdominal or flank pain or when other diagnoses are unclear [21].

6. Intravenous pyelography (IVP): This contrast-based imaging method can visualize stones and assess their effect on urine flow.

7. Magnetic resonance imaging (MRI): Used in special cases. Although not commonly used for routine stone evaluation, MRI may be used in specific cases where radiation exposure must be avoided or when other imaging findings are inconclusive.

2. The history of the lasers

The conceptual foundation for laser technology was laid in 1917 when Albert Einstein proposed the principle of stimulated emission of radiation, a fundamental mechanism in laser operation. This theoretical insight formed the foundation for future laser development. Several decades later, in 1960, Theodore Maiman succeeded in constructing the first working laser, which used a synthetic ruby crystal as the gain medium and produced a deep red beam with a wavelength of 694.3 nm [22]. Laser technology continued to develop at an accelerated pace. In 1964, the first carbon dioxide (CO_2) laser was introduced, initially producing only 1 milliwatt. However, by 1967, researchers had succeeded in producing CO_2 lasers with power exceeding 1,000 watts, achieving a quantum leap. The development has opened the door for lasers to participate in the medical field in various specialties. One of the most prominent types of lasers that has shone brightly since its discovery is the Nd:YAG laser, developed in 1964. The Nd:YAG laser emits a beam with a wavelength of 1064 nanometers, distinguished by its high ability to penetrate deep soft tissue without damaging superficial tissue [23]. It is currently used in various industrial and applied fields, such as cutting, welding, drilling, surface treatment of metals, ceramics, and other materials, engraving, and 3D printing. One of the most prominent uses of the Nd:YAG laser in the medical field is its use in fragmenting urinary tract stones. It has allowed doctors to fragment stones inside the kidneys, ureters, and bladder using an endoscope, without the need for a surgical incision [24].

2.1 The Nd:YAG laser

The Nd:YAG laser is a solid-state laser, with a YAG crystal doped with neodymium ions ($Nd+^3$). The laser emits a wavelength of 1064 nm, the fundamental wavelength, and operates in both pulsed and continuous modes. Pulsed lasers typically operate in what is called Q-switched mode and use a pumping source, often a flash lamp or laser diode. These lasers are air- or water-cooled, depending on the laser power. Nd:YAG is an abbreviation for "neodymium-doped yttrium aluminum garnet." The laser operates by directing the laser beam to the area to be treated using lenses or optical fibers, depending on the application [25]. Lenses are used in industrial and applied fields, and fibers are used as an alternative to deep surgery, enabling them to penetrate deep tissue with minimal surface damage. It can be converted to other wavelengths using frequency conversion techniques, such as 532 nm (green) or 355 nm (ultraviolet/blue), making it suitable for a range of applications [26].

2.2 Clinical Applications of the Nd:YAG Laser in Lithotripsy

Approximately 30,000 urinary tract stone fragmentation procedures are performed annually [27].In laser lithotripsy for small and medium-sized urinary stones (<1.5 cm), a rigid or flexible ureteroscope is passed through the urinary tract for illumination and imaging, while an optical laser fiber is inserted through the scope to the stone site in the bladder, ureter, or kidney to target and fragment the stone. The mechanism of laser use in medicine depends on its interaction with tissue. When laser energy is applied to a urinary stone, three main mechanisms may occur: photo-thermal reactions, photochemical reactions, and photomechanical reactions. Of these, the photo-thermal effect is the most widely used and effective for various stone compositions [28]. During this process, the stone absorbs the laser energy, resulting in a rapid rise in temperature, which causes the stone surface to dry out, vaporize, and carbonize. This thermal damage ultimately results in pitting of the stone [29]. Although the photoacoustic effect contributes slightly to mechanical fragmentation, it facilitates optical decomposition and plasma generation. These processes produce shock waves and cavitation bubbles, which further aid stone fragmentation [30]. Effective stone fragmentation depends on two main factors: the physical and chemical properties of the stone and the calibration of the laser settings. Important laser parameters include wavelength, pulse energy, and pulse duration [29]. These parameters are adjusted based on the surgical approach (whether debulking or fragmentation), stone size, composition, and location. In clinical practice, three main parameters are routinely adjusted: frequency (number of pulses per second, measured in hertz), pulse duration (the time the laser emits energy in each pulse, measured in microseconds), and pulse energy (the total energy per pulse, measured in joules). For fragmentation techniques, lower frequency (5–10 Hz) with higher pulse energy (0.8–1.5 J) is preferred. In contrast, debulking protocols typically use higher frequency (50–80 Hz) with lower pulse energy (0.2–0.6 J) [28]. Laser pulse duration is a mechanical property that has recently gained widespread attention, as it has become possible to relate the stone propulsion force, fragmentation efficiency, and fiber burning to this property.

2.3 Kidney Stone Lithotripsy Using Nd:YAG Laser

Laser lithotripsy represents a qualitative development in urological surgery, as it contributes to reducing the rate of traditional surgical intervention, especially in cases of complex kidney stones. One of the types of lasers used in this field is the neodymium-YAG (Nd:YAG) laser, which was one of the first lasers used to fragment stones within the urinary tract. This laser is characterized by its ability to penetrate deep tissue. It operates in pulsed mode, emitting pulses at short intervals and high energy, thus providing a very high laser power. These pulses fragment the stone using a thermomechanical mechanism. The Freddy laser (frequency-doubled dual pulse Nd:YAG laser) emits two consecutive pulses, one with a wavelength of 532 nm (in the visible range) and the other with a wavelength of 1064 nm (in the infrared range). This dual-wavelength configuration enhances stone fragmentation by combining thermal and mechanical effects [31]. The Nd:YAG laser is best used in cases requiring deep tissue penetration or for stones that are stuck in difficult anatomical areas, such as the inferior calyces of the kidney. This technique has been successfully used in endoscopic bile duct stone fragmentation, demonstrating its high efficacy in humid and complex environments [32]. Kidney stone fragmentation usually requires anesthesia and is performed using a uroscope, which is inserted through the urethra to access the renal pelvis. A thin optical fiber, typically between 200 and 600 microns in diameter, is passed through the scope's working channel. When the fiber's tip is directed toward the stone's surface, the laser is activated, emitting light pulses that are absorbed by the stone. When the laser is focused on the stone and activated, the stone absorbs its pulses, causing a rapid rise in temperature and, as a result, disruption of its crystalline structure.Simultaneously, the surrounding fluid vaporizes, forming microbubbles that collapse and generate localized shock waves, further fragmenting the stone [33]. The resulting fragments are removed by saline irrigation or aspiration, and in some cases, extraction baskets are used.

2.3.1 Ureteral Stone Lithotripsy Using the Nd:YAG Laser

The ureter is a narrow tubular structure, approximately 20–30 cm long, with an internal diameter of 3–5 mm, and lined with fine smooth muscle. These anatomical characteristics require the use of highly flexible laser fibers and minimally invasive energy delivery. Optical fibers with diameters between 280 and 365 μm are preferred to ensure ease of movement and reduce the risk of ureteral wall injury. In clinical settings, the Freddy laser has proven effective in fragmenting ureteric stones, typically using energy levels between 300 and 400 J to achieve effective fragmentation. Studies have shown that, with a total energy output of 400 J, this laser system can fragment up to 86.8% of the stone mass [34]. When used carefully, the Nd:YAG laser fragments stones effectively while minimizing the risk of ureteral injury. Although moderate stone displacement (stone displacement)—ranging from 6.8 to 8.1 cm—can occur, it can often be controlled with anti-displacement devices. Initial clinical trials have reported stone-free rates of up to 94% across all ureteral segments, including the upper, middle, and lower segments.

2.3.2 Bladder Stone Lithotripsy Using the Nd:YAG Laser

The primary cause of bladder stone formation is urinary stasis, which is common in conditions such as benign prostatic hyperplasia and neurogenic bladder dysfunction [35]. While some bladder stones may originate as migrating stones or squamous papillae from the kidney, most are newly formed within the bladder. Small kidney stones typically pass through the ureter and enter the bladder without difficulty, provided there is no significant anatomical obstruction or dysfunction .Stones that remain in the bladder will form additional concentric layers of material or mineral deposits, which may or may not be compatible with the original material [36]. Laser treatment of bladder stones has grown in popularity due to its high stone-free success rate, low complication rate, and the possibility of combining it with other urological procedures, such as prostatectomy and ureteroscopy [37]. Bladder stone fragmentation is performed when the doctor inserts a cystoscope through the urethra and locates the stone within the bladder. Laser energy is then directed to fragment the stone into fragments that can be aspirated or allowed to pass naturally. The Nd:YAG laser is particularly useful when the stones are very large or very hard. The laser generates heat to vaporize water and create thermal fissures within the stone structure, promoting fragmentation. An advantage of this method is that it does not require open surgery, even for large stones. It is suitable for patients who cannot tolerate prolonged anesthesia. It also reduces the risk of infection and bleeding compared to traditional surgery.

2.4 Types of lasers used to Lithotripsy urinary tract stones:

2.4.1 Holmium Laser: Ho:YAG Laser

The holmium:YAG laser is currently the primary technology used in laser lithotripsy due to its favorable interaction with water and biological tissue. The laser emits light in the infrared range with a wavelength of 2140 nm, and its energy is rapidly absorbed in aqueous environments, allowing for precise and safe fragmentation of urinary tract stones without causing collateral tissue damage [38]. It has a shallow penetration depth, approximately 0.3–0.5 mm in liquids, making it particularly suitable for use in narrow anatomical spaces such as the ureter and renal pelvis. . The mechanism of action involves delivering focused elevated thermal energy directly to the stone surface, breaking it apart while preserving adjacent tissues. Ho:YAG lasers are versatile and capable of treating various stone types, including calcium oxalate, uric acid, and struvite compositions. A flexible endoscope is used to access the urinary tract via the urethra, and a miniature camera helps localize the stone. The laser fiber is then directed toward the stone to emit precise pulses that reduce the stone to smaller fragments. These fragments can either be extracted or left to pass naturally through urination. Ho:YAG lasers are available in different power configurations. Low-power systems typically offer up to 30–35 watts and operate at frequencies of 25–30 Hz [38]. In contrast, high-power units can reach up to 100–120 watts, offering more flexibility in adjusting parameters such as pulse energy, frequency, and duration [39]. Depending on the selected parameters, high-energy and low-frequency settings are used for fragmentation (breaking the stone into smaller pieces), while low-energy and high-frequency settings are preferred for dusting (pulverizing stones into fine particles that can exit the body spontaneously) [40]. Dusting has gained popularity over traditional fragmentation because it reduces operative time and minimizes the need for retrieval tools such as baskets. In some cases, an additional non-contact lithotripsy stage is performed to ensure finer debris production for easier natural passage. Two techniques commonly used in this phase are “popcorn” and “pop-dust.” The popcorn technique utilizes higher pulse energy (around 1.5 J) at frequencies between 20–40 Hz with long pulse durations to create clinically insignificant debris. The pop-dust technique, in contrast, uses lower energy levels (0.5–0.8 J) and longer pulses to produce even finer particles. This technique has been shown to improve the effectiveness of stone removal in both children and adults. [41].

2.4.2 Thulium Fiber Laser (TFL)

The TFL laser's active medium is a long, thin thulium-doped silica fiber. This fiber is pumped using a diode laser emitting pulses at a wavelength of 1940 nm. This laser operates in pulsed and continuous mode and generates very low heat, enabling it to be air-cooled. This device was developed to improve the accuracy, safety, and efficiency of stone fragmentation. Compared to the holmium:YAG laser, especially at various settings and operating modes, the TFL laser is more efficient at fragmenting stones. This is because the laser's emission spectrum matches the water absorption peak. This results in two main advantages: first, improved stone fragmentation performance, and second, reduced thermal damage to surrounding tissue. Compared to the holmium:YAG laser, water absorbs TFL energy up to four times more efficiently than the holmium:YAG laser, enhancing stone fragmentation efficiency. A distinctive feature of TFL laser systems is their ability to reach pulse frequencies of up to 2100 Hz, far exceeding the capabilities of the holmium:YAG laser. This makes the TFL highly adaptable to various lithotripsy techniques, including dust removal and microparticle generation [42]. The current TFL pulse energy range is between 0.025 and 6 J, allowing the use of lower energy levels to produce finer debris suitable for aspiration, thus reducing stone rebound, where the stone vibrates rather than bounces during treatment [43]. While these higher pulse frequencies are technically feasible, the highest pulse rate used in practice to date is approximately 500 Hz [44]. Operating at these higher frequencies allows for effective fragmentation using lower pulse energies, contributing to a more controlled and efficient procedure. Furthermore, TFL systems utilize air cooling—unlike Ho:YAG lasers, which require water cooling—due to their high energy efficiency and low heat production. This contributes to simplified maintenance and a more compact device design. Additionally, TFL offers precise control over pulse duration, ranging from 200 to 1100 microseconds, providing flexibility in customizing the fragmentation process based on stone composition and anatomical considerations [45].

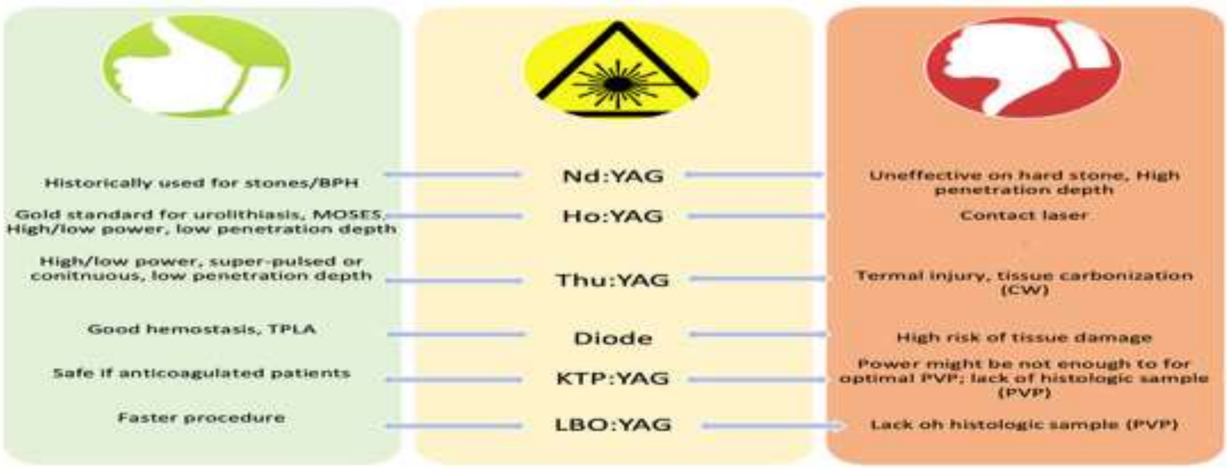

Figure (3): It shows the name of the laser and the advantages and disadvantages in the field of stone Lithotripsy [45].

Comparative Table: Nd:YAG vs Ho:YAG vs Thulium Fiber Laser (TFL)

Feature	**Nd:YAG Laser**	**Ho:YAG Laser**	**Thulium Fiber Laser (TFL)**
Wavelength	1064 nm	2140 nm	1940 nm
Tissue Penetration	Deep penetration	Shallow (0.3–0.5 mm)	Moderate
Water Absorption	Low	High	Very high
Fragmentation Efficiency	Moderate	High	Very high
Retropulsion	High	Moderate	Low
Pulse Frequency Range	Up to ~20 Hz	Up to ~80 Hz	Up to 2100 Hz
Cooling System	Air or water cooled	Water cooled	Air cooled
Clinical Usage	Rare, selective cases	Used in most clinical cases	Recently introduced; gaining popularity for dusting techniques
Cost	Moderate	High	Lower than Ho:YAG
Best Suited For	Deep-seated or large stones	Most types and locations of urinary stones	Fine fragmentation, soft stones, minimal retropulsion

3. Conclusion

The advancement of laser technology has opened new horizons for urologists in managing urinary tract stones with greater precision and less invasiveness. The integration of laser systems particularly Nd:YAG, Ho:YAG, and thulium fiber lasers has led to significant progress in endourologic procedures. These technologies provide accurate, non-invasive solutions and have proven highly effective in fragmenting stones located in the kidney, ureter, and bladder. Of all the modalities, the Ho:YAG laser remains the most widely used and reliable tool for stone fragmentation, due to its optimal interaction with water and biological tissue. At the same time, newer technologies, such as the thulium fiber laser (TFL), are showing encouraging improvements in both safety and efficacy. Despite the important role of the Nd:YAG laser, its current use is largely limited to select clinical situations due to its deep tissue penetration and associated thermal hazards. Future studies in this area should work to reduce thermal damage and optimize energy settings. In our research, we discussed the different types of lasers used in urinary tract stone fragmentation Nd:YAG, Ho:YAG, and TFL and concluded that each has advantages and disadvantages. Each treats a specific condition and cannot be used in all cases. To select the appropriate laser for a patient's condition, a comprehensive examination of the stone's composition, size, and location, as well as information about their overall health, should be performed. This information will help us achieve better results with fewer side effects.

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