The Holmium:YAG (Ho:YAG) laser is one of the most versatile surgical laser currently in the armamentarium of today's laser urologist. The Ho:YAG's unique ability to vaporize, ablate and coagulate both soft tissues and extremely hard, dense tissues have made it the laser of choice mainly in Urology, Orthopaedics, with minor applications in ENT, Gynaecology and for General, and Maxillofacial Surgery; Neurosurgery, and Gastroenterology.

Control of thermal penetration, haemostasis in virtually any tissue, delivery systems that allow access to even the tightest spaces and a wide variety of tissue effects are just a few of the many benefits the Ho:YAG laser can bring to patients.

The Ho:YAG laser has become the standard of care among practicing urologists for the treatment of renal calculi approached in a retrograde fashion, urethral stones, bladder stones, superficial bladder carcinoma, strictures and BPH requiring surgical intervention.

For use with or without an endoscope with or without a working channel. Prior to use, physicians must be fully acquainted with genitourinary/urology procedures.
1. Indications

1.1. Lithotripsy and Percutaneous Urinary Lithotripsy.

Ablation and vaporization, with or without an endoscope, in lithotripsy and percutaneous urinary lithotripsy, including fragmentation of urinary calculi, urethral calculi, kidney calculi, and treatment of distal impacted fragment of steinstrasse when guide wires cannot be passed.

1.2. Genitourinary Surgery.

Incision, excision, resection, ablation, coagulation, hemostasis and vaporization, with or without an endoscope, of genitourinary/urology tissue including:

1. Lesions of the external genitalia
2. Condylomas
3. Urethral and penile hemangioma
2. Lithotripsy and Percutaneous Urinary Lithotripsy

The efficacy of the Ho:YAG laser as a lithotritter is well documented in current literature. The laser has the unique ability to vaporize, or reduce to a fine grit, virtually any stone, regardless of its composition or colour. This allows the surgeon to expect a stone free patient every case, providing the stone can be visualized. Ho:YAG lithotripsy generates the smallest stone fragments of any lithotripsy device currently available to the practicing urologist. The combination of small fragment size and outstanding probe flexibility typically allows access and visibility to be maintained at all times.

For use with or without an endoscope with or without a working channel. Prior to use, physicians must be fully acquainted with lithotripsy and percutaneous lithotripsy procedures.

2.1. Indications

Incision, excision, resection, ablation, coagulation, haemostasis and vaporization, with or without an endoscope, in lithotripsy and percutaneous urinary lithotripsy, including fragmentation of:

1. Urinary calculi
2. Urethral calculi
3. Kidney calculi

2.2. Scientific Literature in Ho:YAG Lithotripsy

Holmium:YAG Lithotripsy Yields Smaller Fragments Than Lithoclast, Pulsed Dye Laser or Electrohydraulic Lithotripsy.

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PURPOSE: The mechanism of lithotripsy differs among electrohydraulic lithotripsy, mechanical lithotripsy, pulsed dye lasers and holmium:YAG lithotripsy. It is postulated that fragment size from each of these lithotrites might also differ. This study tests the hypothesis that holmium:YAG lithotripsy yields the smallest fragments among these lithotrites. MATERIALS AND METHODS: We tested 3F electrohydraulic lithotripsy, 2 mm. mechanical lithotripsy, 320 microns pulsed dye lasers and 365 microns. Ho:YAG fiber on stones composed of calcium hydrogen phosphate dihydrate, calcium oxalate monohydrate, cystine, magnesium ammonium phosphate and uric acid. Fragments were dessicated and sorted by size. Fragment size distribution was compared among lithotrites for each composition. RESULTS: Ho:YAG fragments were significantly smaller on average.
than fragments from the other lithotrites for all compositions. There were no Ho:YAG fragments greater than 4 mm., whereas there were for the other lithotrites. Ho:YAG had significantly greater weight of fragments less than 1 mm. compared to the other lithotrites. CONCLUSIONS: H:YAG yields smaller fragments compared to electrohydraulic lithotripsy, mechanical lithotripsy or pulsed dye lasers. These findings imply that fragments from Ho:YAG lithotripsy are more likely to pass without problem compared to the other lithotrites. Furthermore, the significant difference in fragment size adds evidence that Ho:YAG lithotripsy involves vaporization.


Transient Cavitation and Acoustic Emission Produced by Different Laser Lithotripters.

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Transient cavitation and shockwave generation produced by pulsed-dye and holmium:YAG laser lithotripters were studied using high-speed photography and acoustic emission measurements. In addition, stone phantoms were used to compare the fragmentation efficiency of various laser and electrohydraulic lithotripters. The pulsed-dye laser, with a wavelength (504 nm) strongly absorbed by most stone materials but not by water, and a short pulse duration of approximately 1 microsec, induces plasma formation on the surface of the target calculi. Subsequently, the rapid expansion of the plasma forms a cavitation bubble, which expands spherically to a maximum size and then collapses violently, leading to strong shockwave generation and microjet impingement, which comprises the primary mechanism for stone fragmentation with short-pulse lasers. In contrast, the holmium laser, with a wavelength (2100 nm) most strongly absorbed by water as well as by all stone materials and a long pulse duration of 250 to 350 microsec, produces an elongated, pear-shaped cavitation bubble at the tip of the optical fiber that forms a vapor channel to conduct the ensuing laser energy to the target stone (Moss effect). The expansion and subsequent collapse of the elongated bubble is asymmetric, resulting in weak shockwave generation and microjet impingement. Thus, stone fragmentation in holmium laser lithotripsy is caused primarily by thermal ablation (drilling effect).


Retrograde Ureteropyeloscopy for Lower Pole Caliceal Calculi.

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PURPOSE: Contemporary treatment of lower pole renal calculi includes extracorporeal shock wave lithotripsy, percutaneous nephrostolithotomy and retrograde
ureteropyeloscopy. Success rates for shock wave lithotripsy are reduced in this setting, especially for stones greater than 1 cm. and/or in patients with anatomical variants. Percutaneous treatment, although effective, subjects the patient to increased morbidity. We studied the safety and efficacy of retrograde ureteroscopic treatment of lower pole intrarenal calculi. MATERIALS AND METHODS: We evaluated 90 stone burdens localized to the lower pole and treated with a small diameter, actively deflectable, flexible ureteropyeloscope and a 200 micron holmium laser fiber. Stone burdens were classified as group 1--10 or less, group 2--11 to 20 and group 3--greater than 20 mm. in largest diameter. Patients with calculi less than 2.5 cm. were treated as outpatients unless concurrent medical conditions required hospitalization. Larger stones and partial staghorn calculi (group 3) frequently required 2-stage endoscopic procedures with retrograde intrarenal irrigation for 36 hours to clear debris. An acceptable immediate surgical outcome was defined as complete fragmentation reducing the stone burden to dust and 2 mm. or less fragments. Success was defined as clear imaging (that is stone-free) on renal sonography with minimum 3-month followup. Extreme anatomical variants, including a long infundibulum, acute infundibulopelvic angle and a dilated collecting system, were noted and correlated with surgical failures. RESULTS: Endoscopic access and complete stone fragmentation were achieved in 94, 95 and 45% of groups 1, 2 and 3, respectively. After a second treatment the success rate increased to 82% in group 3, with an overall rate of 91%. Of the 19 surgical failures 8 were secondary to inability to access the lower pole and 11 were secondary to inability to render the patient stone-free. In 2 of the 19 cases infundibular strictures hindered ureteroscopic access. In addition, of the anatomical variants a long lower pole infundibulum was the most statistically significant predictor of failure. Mean operative time ranged from 38 minutes for small to 126 for the largest calculi. There were no major complications. Overall stone-free rates with minimum 3-month followup were 82, 71 and 65% in groups 1, 2 and 3, respectively, and 88, 77 and 81%, respectively, in patients with an acceptable initial surgical outcome (that is excluding those with access failures from analysis). CONCLUSIONS: Retrograde ureteropyeloscopy is a safe and effective surgical treatment for lower pole intrarenal calculi.


Holmium:YAG Lithotripsy in Children.

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PURPOSE: We determined the safety and efficacy of holmium:YAG lithotripsy in children. MATERIALS AND METHODS: We retrospectively reviewed the records of all holmium:YAG lithotripsy done in patients 17 years old or younger. Demographic, preoperative, intraoperative and postoperative data were collected. RESULTS: A total of 9 boys and 10 girls (26 stones) with a mean age of 11 years (range 1 to 17) were treated with holmium:YAG lithotripsy, which was chosen as initial therapy in 10 (53%). Retrograde ureteroscopy was performed in 15 patients to treat 13 ureteral and 6 renal calculi, and percutaneous nephrolithotripsy was done in 4 to treat 3 ureteral and 4 renal calculi. A complete stone-free outcome after 1 procedure was achieved in 16 children (84%) and 3 patients were rendered stone-free after 2 procedures. No patient had an intraoperative injury. Followup ranged from 0.5 to 12 months (mean 3). Followup imaging has shown no
evidence of stricture or hydronephrosis. CONCLUSIONS: Holmium:YAG lithotripsy is safe and effective in children. It is a reasonable option for failed shock wave lithotripsy, or in children with a known durile stone composition or contraindications to shock wave lithotripsy.


Initial Experience With Endoscopic Holmium Laser Lithotripsy for Pediatric Urolithiasis.

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PURPOSE: Due to the unavailability of suitable pediatric instruments children have not benefited from advances in endoscopic lithotripsy. This limitation may be overcome by the holmium: YAG laser. We evaluated the indications for, and efficacy and complications of holmium:YAG laser lithotripsy. MATERIALS AND METHODS: We retrospectively reviewed all cases of laser lithotripsy. Access to the calculus was antegrade or retrograde. A solid state holmium:YAG laser was used. RESULTS: Eight patients 4 to 14 years old underwent laser lithotripsy during the study period. Average calculous surface area was 357.13 mm.2 (range 14 to 1,645). Five patients required 1 procedure to render them stone-free, while the remaining 3 required multiple procedures. No complications were associated with laser lithotripsy. CONCLUSIONS: The ability of the holmium:YAG laser to pulverize urinary calculi makes it an alternative choice for lithotripsy. In our series all patients are stone-free with stable renal function. The advantages of the holmium:YAG laser are that it may be precisely applied via small fibers, and it pulverizes calculi with minimal scattering of energy and retropulsion of the calculus, decreasing trauma to tissues at the perioperative site. There is also a lower risk of residual fragments, which is associated with a lower incidence of calculous regrowth. Ho:YAG laser is safe and effective for treating pediatric urolithiasis.


Holmium Laser Lithotripsy of a Complicated Biliary Calculus.

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More than 500,000 cholecystectomies are performed annually. Extracorporeal shockwave lithotripsy and endoscopic laser lithotripsy have been used for the management of common bile duct calculi, which complicate 10% of cases. We report the first successful clinical application of the Ho:YAG laser to a complex biliary calculus case.

Endourol. 1999 Sep;13(7):499-503.

Identifying Stone Composition Using Infrared Analysis of Filtered Urine After Ureteroscopic Lithotripsy.

BACKGROUND AND PURPOSE: With the development of small-caliber ureteroscopes and lithotripsy devices, it is now possible to perform intracorporeal stone fragmentation without dilatation of the ureteral orifice. Ureteral stones are typically fragmented into small particles that can be difficult to retrieve for stone analysis. Infrared spectroscopy (IRS) of the precipitate from urine after intracorporeal lithotripsy represents a method for obtaining stone analysis. PATIENTS AND METHODS: A total of 69 patients underwent ureteroscopic lithotripsy with the holmium laser or the electrohydraulic probe for stones in the ureter (N = 65) or kidney (N = 4). Each patient's bladder was then drained and the urine filtered. The resulting precipitate was analyzed using IRS. RESULTS: The amount of material for analysis was < or =1 mg in 56 patients (82%). Stone composition was positively identified in 44 patients (64%). Material suitable for analysis was recovered from 73% of patients when the bladder was drained with a cystoscope sheath compared with 43% when a urethral catheter was used (P = 0.03). There was no significant difference in pretreatment stone size in the patients who had a positive v a negative result (11.7 mm v 10.9 mm; P = 0.06). Similarly, the stone location was not significantly related to the likelihood of positive analysis (P = 0.29). CONCLUSION: Straining the urine after ureteroscopic intracorporeal lithotripsy and analyzing the precipitate with IRS is able to identify stone composition in the majority of patients. This method is especially useful in the setting of holmium laser lithotripsy, in which the majority of the stone is converted to spontaneously passable particles.

**J Endourol. 1999 Sep;13(7):477-80; discussion 481-2.**

**Holmium:YAG Lithotripsy for Large Renal and Bladder calculi: Strategies for Efficient Lithotripsy.**

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Holmium:YAG lithotripsy is effective for all stone compositions, and high success rates may be expected. Large renal and bladder calculi may be treated effectively with Ho:YAG lasertripsy. Using angled optical fibers and increasing power settings may be particularly useful to increase lithotripsy speed.

**J Urol. 1999 Nov;162(5):1666-9.**

**Proteus Mirabilis Viability After Lithotripsy of Struvite Calculi.**

Prabakharan S, Teichman JM, Spore SS, Sabanegh E, Glickman RD, McLean RJ.

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PURPOSE: We tested the hypotheses that Proteus mirabilis viability of struvite calculi differs after exposure to different lithotripsy modalities and that the photothermal mechanism of holmium:YAG lithotripsy is antibacterial. MATERIALS AND METHODS: Human calculi of known struvite composition (greater than 90% magnesium ammonium phosphate hexohydrate) were incubated with P. mirabilis. Calculi were randomly distributed and fragmented with no lithotripsy (controls), or shock wave, intracorporeal ultrasonic, electrohydraulic, pneumatic, holmium:YAG or pulsed dye laser lithotripsy. After lithotripsy fragments were sonicated and specimens were serially plated for 48 hours at 38C. Bacterial counts and the rate of bacterial sterilization were compared. RESULTS: Median bacterial counts (colony-forming units per ml.) were 8 x 10(6) in controls and 3 x 10(6) in shock wave, 3 x 10(5) in ultrasonic, 4 x 10(5) in electrohydraulic, 8 x 10(6) in pneumatic, 5 x 10(4) in holmium:YAG and 1 x 10(6) in pulsed dye laser lithotripsy cases (p <0.001). The rate of bacterial sterilization was 50% for holmium:YAG lithotripsy treated stones versus 0% for each of the other cohorts (p <0.01). CONCLUSIONS: P. mirabilis viability varies among lithotrites. The photothermal mechanism of holmium:YAG lithotripsy is antibacterial.


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BACKGROUND AND OBJECTIVE: Evidence is presented that the fragmentation process of long-pulse Holmium:YAG (Ho:YAG) lithotripsy is governed by photothermal decomposition of the calculi rather than photomechanical or photoacoustical mechanisms as is widely thought. The clinical Ho:YAG laser lithotripter (2.12 microm, 250 micros) operates in the free-running mode, producing pulse durations much longer than the time required for a sound wave to propagate beyond the optical penetration depth of this wavelength in water. Hence, it is unlikely that shock waves are produced during bubble formation. In addition, the vapor bubble induced by this laser is not spherical. Thus the magnitude of the pressure wave produced at cavitation collapse does not contribute significantly to lithotripsy. STUDY DESIGN/MATERIALS AND METHODS: A fast-flash photography setup was used to capture the dynamics of urinary calculus fragmentation at various delay times following the onset of the Ho:YAG laser pulse. These images were concurrently correlated with pressure measurements obtained with a piezoelectric polyvinylidene-fluoride needle-hydrophone. Stone mass-loss measurements for ablation of urinary calculi (1) in air (dehydrated and hydrated) and in water, and (2) at pre-cooled and at room temperatures were compared. Chemical and composition analyses were performed on the ablation products of several types of Ho:YAG laser irradiated urinary calculi, including calcium oxalate monohydrate (COM), calcium hydrogen phosphate dihydrate (CHPD), magnesium ammonium phosphate hexahydrate (MAPH), cystine, and uric acid calculi. RESULTS: When the optical fiber was placed perpendicularly in contact with the surface of the target, fast-flash photography provided visual evidence that ablation occurred approximately 50 micros after the initiation of the Ho:YAG laser pulse (250-350
micros duration; 375-400 mJ per pulse), long before the collapse of the cavitation bubble. The measured peak acoustical pressure upon cavitation collapse was negligible (< 2 bars), indicating that photomechanical forces were not responsible for the observed fragmentation process. When the fiber was placed in parallel to the calculus surface, the pressure peaks occurring at the collapse of the cavitation were on the order of 20 bars, but no fragmentation occurred. Regardless of fiber orientation, no shock waves were recorded at the beginning of bubble formation. Ablation of COM calculi (a total of 150 J; 0.5 J per pulse at an 8-Hz repetition rate) revealed different Ho:YAG efficiencies for dehydrated calculus, hydrated calculus, and submerged calculus. COM and cystine calculi, pre-cooled at -80 degrees C and then placed in water, yielded lower mass-loss during ablation (20 J, 1.0 J per pulse) compared to the mass-loss of calculi at room temperature. Chemical analyses of the ablated calculi revealed products resulting from thermal decomposition. Calcium carbonate was found in samples composed of COM calculi; calcium pyrophosphate was found in CHPD samples; free sulfur and cysteine were discovered in samples composed of cystine samples; and cyanide was found in samples of uric acid calculi. CONCLUSION: These experimental results provide convincing evidence that long-pulse Ho:YAG laser lithotripsy causes chemical decomposition of urinary calculi as a consequence of a dominant photothermal mechanism.

**J Endourol. 1999 Apr;13(3):181-90.**

**Holmium: YAG Lithotripsy: Photothermal Mechanism.**

Vassar GJ, Chan KF, Teichman JM, Glickman RD, Weintraub ST, Pfefer TJ, Welch AJ.

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OBJECTIVE: A series of experiments were conducted to test the hypothesis that the mechanism of holmium:YAG lithotripsy is photothermal. METHODS AND RESULTS: To show that holmium:YAG lithotripsy requires direct absorption of optical energy, stone loss was compared for 150 J Ho:YAG lithotripsy of calcium oxalate monohydrate (COM) stones for hydrated stones irradiated in water (17+/-3 mg) and hydrated stones irradiated in air (25+/-9 mg) v dehydrated stones irradiated in air (40+/-12 mg) (P < 0.001). To show that Ho:YAG lithotripsy occurs prior to vapor bubble collapse, the dynamics of lithotripsy in water and vapor bubble formation were documented with video flash photography. Holmium:YAG lithotripsy began at 60 microsec, prior to vapor bubble collapse. To show that Ho:YAG lithotripsy is fundamentally related to stone temperature, cystine, and COM mass loss was compared for stones initially at room temperature (approximately 23 degrees C) v frozen stones ablated within 2 minutes after removal from the freezer. Cystine and COM mass losses were greater for stones starting at room temperature than cold (P < or = 0.05). To show that Ho:YAG lithotripsy involves a thermochemical reaction, composition analysis was done before and after lithotripsy. Postlithotripsy, COM yielded calcium carbonate; cystine yielded cysteine and free sulfur; calcium hydrogen phosphate dihydrate yielded calcium pyrophosphate; magnesium ammonium phosphate yielded ammonium carbonate and magnesium carbonate; and uric acid yielded cyanide. To show that Ho:YAG lithotripsy does not create significant shockwaves, pressure transients were measured during lithotripsy using needle hydrophones. Peak pressures were <2 bars. CONCLUSION: The primary mechanism of Ho:YAG lithotripsy is photothermal. There are no significant photoacoustic effects.

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BACKGROUND AND OBJECTIVE: Medical lasers have rapidly expanded in both indications and utilization. We have developed a simple model for the investigation of various modalities of lithotripsy using readily available silicate stones of uniform mass.

MATERIALS AND METHODS: The holmium:YAG was used in these experiments to define the relation between fiber diameter and efficacy of stone fragmentation. For each fiber, lithotripsy was performed in an incremental fashion at 0.6, 0.8, and 1.0 J at a frequency of 10, 16, and 20 pulses per second at each energy level. RESULTS: Total kilojoules did not differ between any fibers investigated, supporting the consistency of our methodology. The power density of the holmium laser energy, as expressed as total kJ/area, decreases in proportion to increasing fiber diameter. We expected an increase in fragmentation success as fiber diameter decreased (at equal energy output). However, peak lithotripsy occurred with the 365- and 550-microm fibers, whereas neither the 200- nor the 1000-microm fibers was effective. CONCLUSION: This model utilizing a silicate stone phantom supports our clinical observation that the 365-microm fiber (and additionally the 550-microm fiber) provides the best method for efficient intracorporeal lithotripsy.

Management of upper urinary tract calculi with ureteroscopic techniques.

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OBJECTIVES: To evaluate our experience in treating 155 patients with upper urinary tract calculi ureteroscopically. The treatment of urinary calculi has remained the most frequent application of ureteroscopy. Miniaturization of semirigid and flexible ureteroscopes has permitted easier access to calculi throughout the urinary tract.

METHODS: Ureteroscopic stone treatment was attempted in 155 patients with upper urinary tract calculi between November 1995 and March 1997. Fifty-nine (38.1%) patients had renal calculi, 82 (52.9%) ureteral, and 14 (9%) had both renal and ureteral calculi. Both semirigid and flexible ureteroscopes were used for treatment (rigid alone in 21 [13.5%], flexible in 64 [41.3%], and both rigid and flexible in 70 [45.2%] patients). Lithotripsy was required in 122 (79%) of the patients. The Ho:YAG laser was used in 113 (92.6%) of these patients. RESULTS: All patients with ureteral calculi (29 proximal, 19 mid, and 34 distal) were successfully cleared after one endoscopic procedure except for 1 patient with a proximal ureteral calculus who had a 4-mm residual fragment in the kidney. Of the 59 patients with renal calculi, 47 (79.7%) were totally clear of stones 1 month after treatment. The remaining 12 (20.3%)
patients had evidence of residual calculi 3 to 4 mm or less in diameter. In patients with combined renal and ureteral calculi, 1 1 of 14 (78.6%) were rendered stone free. The remaining 3 (21.4%) patients had evidence of residual calculi 4 mm in diameter. Overall, 95% of the patients were treated in an outpatient setting. Morbidity was low, with no evidence of stricture. CONCLUSIONS: Ureteroscopy and laser lithotripsy in experienced hands are a safe and reliable method for the treatment of ureteral and even intrarenal calculi.


The Holmium Laser in Urology.

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OBJECTIVE: To review the physics related to the holmium laser, its laser-tissue interactions, and its application to the treatment of urological diseases. SUMMARY AND BACKGROUND DATA: The holmium:YAG laser is a solid-state, pulsed laser that emits light at 2100 nm. It combines the qualities of the carbon dioxide and neodymium:YAG lasers providing both tissue cutting and coagulation in a single device. Since the holmium wavelength can be transmitted down optical fibers, it is especially suited for endoscopic surgery. METHODS: The authors provide a review of the literature as it relates to the holmium laser and its application to urology. RESULTS: The holmium wavelength is strongly absorbed by water. Tissue ablation occurs superficially, providing for precise incision with a thermal injury zone ranging from 0.5 to 1.0 mm. This level of coagulation is sufficient for adequate hemostasis. The most common urologic applications of the holmium laser that have been reported include incision of urethral and ureteral strictures; ablation of superficial transitional cell carcinoma; bladder neck incision and prostate resection; and lithotripsy of urinary calculi. CONCLUSIONS: The holmium: YAG laser is a multi-purpose, multi-specialty surgical laser. It has been shown to be safe and effective for multiple soft tissue applications and stone fragmentation. Its utilization in urology is anticipated to increase with time as a result of these features.


Ureteroscopic Management of Ureteral Calculi: Electrohydraulic Versus Holmium:YAG Lithotripsy.

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PURPOSE: This study compared electrohydraulic and holmium:YAG lithotripsy for ureteral calculi. MATERIALS AND METHODS: Two cohorts of consecutive patients with ureteral calculi treated with ureteroscopic electrohydraulic or holmium:YAG lithotripsy were retrospectively compared. Electrohydraulic lithotripsy was done using a 1.9F fiber at energy settings between 50 and 100 v. Holmium:YAG lithotripsy was done using a 365
microm. fiber at energy settings of 0.6 to 1.5 J. RESULTS: A total of 23 and 47 consecutive patients underwent electrohydraulic and holmium:YAG lithotripsy, respectively. For preoperative calculi less than 15 mm. mean stone size plus or minus standard deviation was 9 +/- 3 versus 9 +/- 3 mm. (p = 0.5), mean operative time was 72 +/- 21 versus 102 +/- 38 minutes (p = 0.004), stone-free rate at the end of ureteroscopy was 65 versus 97 (p < 0.01) and 3-month stone-free rate was 94 versus 97% (p = 0.4) for electrohydraulic versus holmium:YAG lithotripsy. For preoperative calculi 15 mm. or greater stone size was 19 +/- 5 versus 19 +/- 4 mm. (p = 0.9), operative time was 159 +/- 61 versus 108 +/- 27 minutes (p = 0.01), stone-free rate at the end of ureteroscopy was 33 versus 87% (p = 0.001) and 3-month stone-free rate was 67 versus 100% (p = 0.02). Complications were not significantly different in either comparison. CONCLUSIONS: The overall likelihood that a patient would be rendered stone-free at ureteroscopy and 3 months after ureteroscopy favored holmium: YAG over electrohydraulic lithotripsy. For ureteral calculi less than 15 mm. electrohydraulic lithotripsy was more rapid than the holmium:YAG procedure but for ureteral calculi 15 mm. or greater the holmium:YAG technique was more rapid than electrohydraulic lithotripsy. The outcomes differences may have resulted from the different mechanisms of electrohydraulic and holmium:YAG lithotripsy.


Intracorporeal Lithotripsy With the Holmium:YAG Laser.

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PURPOSE: Preliminary evaluations of the holmium:YAG laser have demonstrated a variety of potential urological applications, including ablation of soft tissue lesions as well as stone fragmentation. We present our experience with the holmium:YAG laser for intracorporeal lithotripsy of urinary calculi. MATERIALS AND METHODS: During a 24-month period 75 patients underwent 79 laser procedures, including retrograde ureteroscopy for ureteral calculi (71) and fragmentation of caliceal stones remote from the nephrostomy tract during percutaneous nephrolithotripsy (8). RESULTS: Complete stone fragmentation without need for additional procedures or lithotripsy was achieved in 85% of the cases. Treatment failures included 1 case of stone migration, 7 incomplete fragmentation requiring other lithotripsy devices and 3 laser malfunction. One ureteral perforation occurred when the laser was activated without direct visual guidance. CONCLUSIONS: The holmium:YAG laser has demonstrated its efficacy as a method of intracorporeal lithotripsy. Advantages include ability to fragment stones of all composition, and the multipurpose, multispecialty applications of the holmium wavelength. This laser has potential soft tissue effects, and careful attention to technique during lithotripsy is required to avoid ureteral wall injury.


Cystoscopic Holmium Lithotripsy of Large Bladder Calculi.

McIver BD, Griffin KP, Harris JM, Teichman JM.
Patients with large bladder stones are often difficult to treat endoscopically with the current modalities available to the practicing urologist. We present the results of cystolithotripsy of bladder stones larger than 4 cm with the holmium: Yag (Ho:Yag) laser. In our three patients, all patients were rendered stone free without complication using the Ho:YAG laser, with an average anesthesia time of 50 min. Minimal tissue trauma or stone movement were observed. All stones were easily fragmented, even one stone that had previously been refractory to electrohydraulic lithotripsy. Our conclusion is that the Ho:YAG laser is a safe and effective treatment for patients with large bladder stones. Its use may make it possible to eradicate stones endoscopically that otherwise would require open surgery.


### Intrarenal Use of the Holmium Laser.

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**BACKGROUND AND OBJECTIVE:** We investigated the safety, effectiveness, and techniques of the holmium (Ho:YAG) laser intrarenally. Data are presented on 52 patients who were treated with the Ho:YAG laser intrarena1ly for urinary calculi or neoplasms.

**STUDY DESIGN/MATERIALS AND METHODS:** The Ho:YAG laser has a wavelength of 2,100 nm, which is delivered in pulsed fashion via a small flexible quartz fiber (365 microns), which is placed through a working channel (> 2.2 Fr) of a small diameter endoscope. **RESULTS:** Sixty-three intrarenal procedures were performed with the Ho:YAG laser for calculi and neoplasms. Twenty-four procedures were performed for intrarenal neoplasms. Average total energy used in these patients was 2.61 kilojoules (kJ) with a maximum of 15.28 kJ. Thirty-nine procedures were performed for intrarenal calculi; 7/39 procedures were approached percutaneously. Average total energy in stone patients was 5.41 kJ with a maximum of 37.77 kJ. **CONCLUSION:** The Ho:YAG laser can be used safely and effectively to treat intrarenal calculi or neoplasms. All types of calculi were fragmented and all patients with intrarenal tumor were treated successfully. There were no vascular or renal injuries and there was no evidence of renal loss. No intrarenal strictures were seen on follow-up. The Ho:YAG laser energy can be delivered through a small flexible quartz fiber passed through a small diameter endoscope. The techniques and applications of the Ho:YAG laser make it well suited for urologic application.

**Urology. 1995 Jun;45(6):947-52.**

### Holmium: Yttrium-aluminum-garnet Laser for Endoscopic Lithotripsy.

OBJECTIVES. To evaluate the holmium:yttrium-aluminum-garnet (Ho:YAG) laser for endoscopic lithotripsy on patients diagnosed with urinary tract calculi. METHODS. Thirty-eight procedures utilizing transurethral ureterolithotripsy or percutaneous nephroureteral lithotripsy were evaluated: 5 renal calculi, 31 ureteral calculi (most in the upper ureter), 1 ureteropelvic junction calculus, and 1 bladder calculus. These were mainly in cases that, after being treated with extracorporeal shock-wave lithotripsy (ESWL), were contraindicated for further ESWL. Laser parameters included energy of 0.5 to 1.0 J/pulse and pulse rate of 5 to 10 Hz. RESULTS. Composition of calculi was determined in 26 procedures. The Ho:YAG laser was effective for fragmenting all types of calculi. Patient outcome evaluated at 6 weeks after treatment showed that 33 of 38 procedures (87%) were effective. Residual calculi in 4 of the 5 unsuccessful procedures were less than 5 mm in size and judged to be able to pass spontaneously. In the remaining procedure, the calculus was passed spontaneously 3 months after treatment. No severe damage to tissues or adverse effects to the body were observed due to the Ho:YAG laser. CONCLUSIONS. On the basis of these results, we determine that this wavelength is effective for lithotripsy in addition to its previously reported usefulness for soft tissue applications, and, thus, is a cost-effective and highly useful clinical device.

Use of the Holmium Laser in the Upper Urinary Tract.

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The holmium (Ho:YAG) laser can effectively fragment ureteral calculi of all compositions. It can also ablate tissue including neoplasms. Because the laser light can be carried through small flexible quartz fibers, it is ideally suited for use through small-diameter rigid and flexible ureteroscopes in the upper urinary tract. Although care must be used in application of the laser, the combination of fine control and limited tissue penetration allow it to be used safely in the ureter. Techniques for stone fragmentation, tumor ablation and stricture incision are described in detail.


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To measure the effects of different working instruments and holmium laser fibers on the deflectability in a variety of actively deflectable flexible endoscopes, a benchtop study was performed. The endoscopes studied were the Storz 7.5 flexible ureteroscope, the AUR-7
and AUR-9 flexible ureteroscopes (Circon-ACMI), a prototype Mitsubishi flexible ureteroscope (Mitsubishi Optics, Inc.), the ACN flexible cystoscope (Circon-ACMI), and the Storz flexible cystoscope. Working instruments included 1.6F (Wolf) and 1.9F (Microvasive) electrohydraulic lithotripsy (EHL) probes, 1.9F two-prong graspers and Bagley baskets, 2.4F Segura and helical baskets (Microvasive), 3.0F Segura basket, and 200- and 365-micron holmium laser fibers (Xintec). In ureteroscopes, the effect of 1.6F and 1.9F EHL probes ranged from having no effect in the Xintec 6,000, to decreasing deflection by 30 degrees in the AUR-7. Working instruments that were 2.4F or greater reduced deflection from 33 degrees to 93 degrees. Better deflectability was noted with the 200-micron holmium laser fiber than with the 365-micron fiber. The diameter of the working instrument did not affect deflectability as severely in cystoscopes. No significant differences in deflection existed between the 365-micron and 200-micron fibers in the flexible nephrosopes tested. In general, working instruments less than 2.4F and the 200-micron laser fiber have little effect on deflectability compared with working instruments 2.4F or larger and the 365-micron fiber. Flexible cystoscopes, with their larger working channels and stronger deflection cables, are affected less by working instrument diameter than are flexible ureteroscopes.

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The Case for Primary Endoscopic Management of Upper Urinary Tract Calculi: II. Cost and Outcome Assessment of 112 Primary Ureteral Calculi.

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OBJECTIVES. To compare extracorporeal shock-wave lithotripsy (ESWL) with endoscopic lithotripsy to establish the more efficacious and cost-effective treatment for ureteral calculi.

METHODS. The records of 112 patients with primary ureteral calculi treated at one center with either ESWL or endoscopic lithotripsy were retrospectively reviewed. Follow-up data at 1 and 3 months were obtained in all patients. Success was defined as complete clearance of a stone burden in the endoscopy group. In the ESWL group patients with a residual, asymptomatic 2-mm fragment were also considered successful treatments. The number of auxiliary procedures, retreatments, postoperative office visits, and imaging studies required before a patient was considered stone free was defined. The impact of these variables on global costs was carefully reviewed. RESULTS. Patients with ureteral calculi primarily treated with ESWL or ureteroscopic lithotripsy had stone-free rates after a single session of 45% versus 95% at 1-month follow-up, and 62% versus 97% at 3-month follow-up. Retreatment and auxiliary procedure rates were significantly higher in the ESWL group (31% versus 3%). The mean number of postoperative visits and imaging studies until a patient was stone free was also higher in the ESWL group (2.07 versus 1.13). Operative treatment costs were similar for both modalities, but overall costs weighed heavily against ESWL. CONCLUSIONS. ESWL remains the treatment of choice for moderately sized, uncomplicated renal calculi. In skilled hands, ureteroscopic lithotripsy is by far the most expeditious and cost-effective means of clearing a ureteral stone burden.

Complications employing the holmium:YAG laser.

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We report the operative and early postoperative complications and limitations in 133 patients treated with the holmium laser. Complications included urinary tract infection (N = 3), postoperative bradycardia (1), inverted T-waves (1), intractable flank pain (1), urinary retention (1), inability to access a lower-pole calix with a 365-microm fiber (9), stone migration (5), and termination of procedure because of poor visibility (2). No ureteral perforations or strictures occurred, and no complications were directly attributable to the laser. The holmium laser was capable of fragmenting all urinary calculi in this study. In our initial experience, the holmium laser is safe and effective in the treatment of urinary pathology. Use of laser fibers larger than 200 microm occasionally limits deflection of the endoscope into a lower-pole or dependent calix.
3. Genitourinary Surgery

3.1. Indications

Soft tissue surgery in Urology includes:
1. superficial bladder tumor ablation,
2. incision of ureteral stricture,
3. incision of urethral stricture,
4. relief of ureteropelvic junction obstruction,
5. incision of bladder neck contracture,
6. ureteral tumor ablation,
7. BHP surgery where higher powers (up to 80 W) are required.

3.2. Literature for Soft Tissue Treatment

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Holmium Laser Incision Technique for Ureteral Stricture Using a Small-caliber Ureteroscope.

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BACKGROUND AND OBJECTIVES: The holmium laser has a short absorption depth in tissue and possesses excellent properties both in ablation and hemostasis. We have performed endoscopic incision for ureteral stricture using the holmium laser through a small-caliber ureteroscope. METHODS: This method was used on five patients and seven ureters. The etiology of the stricture was stone scar in two patients, ureteroureteranastomosis of Indiana urinary pouch in two, and primary in one. We used an 8F semi-rigid or 6.9F flexible ureteroscope. No prior procedures, such as balloon dilation, were necessary in any of the cases. The stricture was incised with the holmium laser using a 365-microm fiber through the working channel of the ureteroscope. The holmium laser operated at a wavelength of 2100 nm, with an output of 1.0 J/pulse at a rate of 10 Hz. After completion of the incision, a 12F Double-J catheter was left in for six weeks. RESULTS: The mean operative time was 89 minutes. The stricture resolved completely in all cases at an average follow-up of 8.6 months. CONCLUSIONS: The holmium laser incision for ureteral stricture using a small-caliber ureteroscope is an easy-to-perform, safe and effective procedure.


Retrograde Ureteroscopic Endopyelotomy for the Treatment of Primary and Secondary Ureteropelvic Junction Obstruction in Children.

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The use of endopyelotomy in children with ureteropelvic junction (UPJ) obstruction remains controversial. Although most investigators reported good results with percutaneous or retrograde balloon cautery incision, there are distinct advantages associated with a ureteroscopic approach. Three male children, ages 11, 12 and 17 years, underwent ureteroscopic endopyelotomy for treatment of UPJ obstruction (one primary and two secondary). The procedures were performed using 6F to 8.5F semirigid instruments and the holmium laser. All three patients underwent endopyelotomy without complication. The mean operative time was 80 minutes. Two patients were discharged home the day of the procedure, and the third patient was hospitalized for less than 24 hours postoperatively. With follow-up of 6 to 11 months, two patients are asymptomatic, with no radiographic evidence of obstruction. The 12-year-old boy had continued obstruction following endopyelotomy. At the time of open pyeloplasty, a large crossing vessel was noted, which appeared to be the source of obstruction. Ureteroscopic endopyelotomy can be performed with minimal morbidity and hospitalization in children. Further clinical experience is needed to assess the relative efficacy of this procedure in comparison with other forms of endopyelotomy in children.


Retrograde Ureteroscopic Incision for the Treatment of Nonureteroenteric Ureteral Strictures.

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A variety of methods are available for the management of patients with ureteral strictures. Ureteroscopic, retrograde incision using the holmium laser was performed on an outpatient basis or with hospitalization for <24 hours in three patients with strictures of varying etiologies. With follow-up of 4 to 12 months, all patients have remained asymptomatic without radiographic evidence of recurrent strictures. Retrograde ureteroscopic incision is an effective, minimally invasive option for patients with benign ureteral strictures.


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An infundibular stenosis is defined by a dilated calyx draining through a narrowed infundibulum into a nondistended renal pelvis. We describe the use of ureteroscopy and the holmium:yttrium-aluminum-garnet (YAG) laser to successfully treat an infundibular stenosis in a 27-year-old woman who presented with left flank pain. The holmium:YAG laser is well suited for this application. It can be applied with precise control of the direction and depth of the cut. The retrograde approach avoids the morbidity of a percutaneous nephrostomy and is well suited for treating an anterior infundibular stenosis.


Holmium: YAG Laser Endoureterotomy in the Treatment of Ureteroenteric Strictures Following Orthotopic Urinary Diversion.

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The management of ureteroenteric strictures in patients who have undergone urinary diversion can be challenging. In those patients with an orthotopic neobladder, anastomotic ureteral strictures can be treated endoscopically using a retrograde or antegrade approach. The availability of small (7.5F) flexible ureteroscopes, as well as the use of the Holmium laser has facilitated the ability to precisely incise the stricture under direct endoscopic visualization (endoureterotomy). We describe our technique for laser endoureterotomy in patients with ureteroenteric strictures following orthotopic urinary diversion.


Ho:YAG Laser Resection of the Prostate.

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The holmium laser is a relatively new multipurpose medical laser that recently became available for use in urology. There has been considerable interest in this device, as it seems to combine the cutting properties of the carbon dioxide laser with the coagulating properties of the neodymium:YAG laser, making it particularly appealing for many surgical applications. The last decade has seen enthusiasm for the use of laser energy for the treatment of benign prostatic hyperplasia. In this article, we review the technique of Ho:YAG laser resection of the prostate, including the essential equipment and perioperative patient care.


Holmium Laser Resection of the Prostate.

Le Duc A, Gilling PJ.
OBJECTIVE: This review of holmium laser resection of the prostate (HoLRP) summarises the evolution, points of technique, results of clinical trials and ongoing research concerning this procedure. METHODS: Over 3 years of experience with holmium resection/enucleation in two institutions is reviewed. Several open studies and 2 randomised trials are presented and the results discussed. Current work with holmium enucleation of the prostate (HoLEP) in combination with intracavitary morcellation is also reported. RESULTS: HoLRP results in fewer blood transfusions, less nursing contact time, less requirement for bladder irrigation, and a shorter catheter time and hospital stay than for patients treated with standard electrocautery resection of the prostate (TURP). Preliminary results suggest equivalent symptomatic relief, and relief of bladder outflow obstruction between the two procedures. CONCLUSIONS: Holmium prostatectomy continues to evolve. Preliminary experience suggests that it may be a viable alternative to TURP and appears to have some significant advantages. Newer techniques for tissue retrieval may significantly decrease the operating time.


Ureteroscopic Endopyelotomy in the Treatment of Patients with Ureteropelvic Junction Obstruction.

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OBJECTIVES: To investigate the effectiveness and morbidity of ureteroscopic endopyelotomy in adults with ureteropelvic junction (UPJ) obstruction. METHODS: Twenty-two patients (13 women, 9 men) with a mean age of 44 years (range 18 to 86) underwent retrograde ureteroscopic endopyelotomy in the treatment of primary (n = 18) or secondary (n = 4) UPJ obstruction. All procedures were performed using a 6F to 8.5F semirigid ureteroscope with either a 3F electrocautery probe (n = 16) or a 365-microm holmium laser fiber (n = 6). Postoperatively, a tapered 14/7F endoureterotomy stent (n = 11) or standard 7F to 8F double pigtail stent (n = 11) was left in place for 6 to 7 weeks. Radiographic follow-up was obtained using intravenous urography or renal scintigraphy. RESULTS: With a median follow-up of 20.5 months, the success rate was 82% (18 of 22 patients). Follow-up of at least 6 and 12 months was available in 21 (95%) and 17 (77%) of 22 patients, respectively. The mean operative duration was 63 minutes, and all but 1 patient was hospitalized for less than 24 hours. No bleeding complications or other serious morbidity were encountered. No difference in treatment outcome was found on the basis of the size of the stent placed postoperatively, the incision type (cautery versus laser), or the etiology of the obstruction. CONCLUSIONS: Ureteroscopic endopyelotomy is an effective, minimally invasive treatment option for patients with primary or secondary UPJ obstruction.


Soft-tissue Applications of the Ho:YAG Laser in Urology.
The holmium:YAG laser possesses both ablative and hemostatic properties and in preliminary clinical use has demonstrated many potential urologic applications. We review our initial experience in treating a variety of soft-tissue lesions of the urinary tract with this laser. A total of 51 patients underwent 53 procedures including superficial bladder tumor ablation (25), incision of ureteral stricture (15), incision of urethral stricture (6), relief of ureteropelvic junction obstruction (3), incision of bladder neck contracture (2), and ureteral tumor ablation (2). Procedures were considered successful, with no further intervention or alternative energy source required, in 81% of the cases. The laser demonstrated precise hemostatic cutting and warrants further investigation as a multipurpose urologic laser.


Use of the Ho:YAG Laser for Treatment of Superficial Bladder Carcinoma.

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This is the first North American report describing the use of the holmium:YAG (Ho:YAG) laser to treat patients with superficial bladder carcinoma. Fifteen patients, with a total of 52 recurrent superficial bladder tumors, underwent endoscopic laser photoablation of their lesions. No intraoperative or delayed complications occurred. At follow-up cystoscopy performed 3 months after lasing, four patients (27%) were without disease; eight patients (53%) had out-of-field recurrences; and three patients (20%) were classified as having in-field recurrences. We conclude that using the Ho:YAG for endoscopic treatment of patients with superficial bladder tumors is both feasible and clinically useful and that the lack of perceived pain or discomfort during lasing, as well as the lack of need for an in-dwelling urethral catheter, makes it advantageous for selected patients over conventional electroresection techniques.


Holmium Laser Resection of Bladder Tumours (HoLRBT).

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We investigated the safety, technique, and effectiveness of holmium laser resection of bladder tumors (HoLRBT). Data are presented on 23 patients who were treated with the HoLRBT technique. Holmium:YAG laser has a wavelength of 2,140 nm, which is delivered in a pulsed fashion via an end-firing quartz fiber placed through a modified resectoscope. Twenty-three patients with newly diagnosed transitional cell carcinoma underwent HoLRBT. Cold cup biopsies of the bladder tumor base were taken and compared to the

HoLRBT specimens. Twenty-two of 23 patients were discharged catheter-free within 24 hours. One patient required a catheter for 3 days. The mean total energy used was 13.14 kJ with a maximum of 34.31 kJ. Mean resection time was 18.6 minutes. Cold cup biopsy of the tumor base did not alter the stage of the bladder tumor. The HoLRBT technique can be used to safely and effectively treat bladder tumors. This laser technique did not alter the stage or the diagnosis of bladder tumors. Holmium resection of bladder tumors usually can be performed as an outpatient catheter-free procedure and is a viable alternative to the standard electrocautery transurethral resection of bladder tumors.


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PURPOSE: Transurethral incision of the prostate is a well established technique for relieving bladder outflow obstruction caused by prostate glands less than 30 gm. We present data showing that the holmium:YAG laser can prevent postoperative catheterization without compromising the outcome of surgery. MATERIALS AND METHODS: We prospectively followed 100 men an average of 62 years old with symptomatic bladder outflow obstruction and a benign prostate gland less than 30 gm. clinically in whom serum prostate specific antigen was less than 4 microg./l. They were assessed using International Prostate Symptom Score, urinary flow rate, post-void residual estimation and sexual function questionnaires preoperatively, and 6 weeks, and 1 and 2 years postoperatively. With the patient under general anesthesia a single incision was made from the ureteral orifice to the verumontanum and out to fat using holmium:YAG laser energy transmitted through a 400 nm. fiber sheathed in a ureteral catheter. RESULTS: A total of 97 patients voided without postoperative catheterization. Average International Prostate Symptom Score decreased from 19.2 to 3.7 at 6 weeks and it remained improved at 2 years (average 3.5). Reciprocal results were achieved with improvement in average urinary flow rate from 9.79 to 19.23 and 18.27 ml. per second at 6 weeks and 2 years, respectively. Residual urine measurement decreased from 133.6 ml. preoperatively to 27 and 10 ml. at 6 weeks and 2 years, respectively. All 77 patients potent preoperatively remained so, although retrograde ejaculation developed in 8. CONCLUSIONS: The holmium:YAG laser allows transurethral prostatic incision to be performed without the need for postoperative catheterization while maintaining efficacy.


Holmium Laser Versus Transurethral Resection of the Prostate: a Randomized Prospective Trial with 1-year Follow-up.

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PURPOSE: The high-powered holmium:YAG laser can be used for incision, ablation and resection of the prostate. The technique of holmium laser resection of the prostate is compared to transurethral prostatic resection for surgical management of benign prostatic hyperplasia in this prospective randomized study. MATERIALS AND METHODS: A total of 120 urodynamically obstructed cases were randomized to holmium laser or transurethral prostatic resection. All eligible patients were assessed preoperatively and at 3 weeks, and 3, 6 and 12 months postoperatively with an American Urological Association symptom score, peak urinary flow rate, and questionnaires concerning sexual function and continence. Preoperative pressure flow study, ultrasound prostate volume assessment and post-void residual urine measurements were repeated at the 6-month visit. All complications were noted. RESULTS: Holmium laser and transurethral resections resulted in significant improvements in symptom score, quality of life score, peak urinary flow rate and post-void residual urine measurements. Operating time was significantly longer in the holmium group but nursing contact time, catheter time and hospital stay were significantly less compared to the transurethral prostatic resection group. Urodynamic results were equivalent at 6 months. There were fewer side effects in the holmium group. Effects on continence, potency and symptoms were similar with 1-year followup. CONCLUSIONS: Holmium and transurethral resections of the prostate appear to be equivalent in surgical management of bladder outflow obstruction due to benign prostate hyperplasia. Perioperative morbidity was less in the holmium group.


Holmium Laser Resection of the Prostate Versus Neodymium:yttrium-aluminum-garnet Visual Laser Ablation of the Prostate: a Randomized Prospective Comparison of Two Techniques for Laser Prostatectomy.


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OBJECTIVES: To directly compare holmium laser resection of the prostate (HoLRP) with neodymium:yttrium-aluminum-garnet visual laser ablation of the prostate (VLAP), which represent two fundamentally different methods of laser prostatectomy. METHODS: In a randomized, prospective comparison, a total of 44 men with symptomatic benign prostatic hyperplasia (BPH) were treated with either HoLRP or VLAP. Standard preoperative assessment included American Urological Association (AUA) symptom score, peak urinary flow rates (Qmax), ultrasound prostate volume, and residual urine measurements. Pressure-flow urodynamics were performed preoperatively and at 3 months postoperatively. Intraoperative and perioperative factors were assessed. The patients were followed at 1, 3, 6, and 12 months following the procedure. RESULTS: There were no significant differences between the patient groups for any preoperative parameter. The mean total operating time was longer in the HoLRP group (52 minutes) compared with the VLAP group (41 minutes) (P <0.01). The mean catheter times were 1.4 days (HoLRP) and 11.6 days (VLAP) (P <0.001). These times included the 9% of patients undergoing HoLRP and 36% of patients undergoing VLAP who required recatheterization. Immediate postoperative dysuria scores were higher in the VLAP group compared with the HoLRP group. There were no significant differences in AUA scores between the two treatment groups at any postoperative interval. The Qmax values were greater at follow-up in the
HoLRP group, but statistical significance was not achieved at 12 months. However, both PdetQmax and Schafer grade measurements taken at 3 months postoperatively were significantly lower in the patients undergoing HoLRP. Three patients (14%) required reoperation in the VLAP treatment arm but no patient who underwent HoLRP has required reoperation to date. CONCLUSIONS: HoLRP results in significantly improved patient outcomes compared to VLAP.