



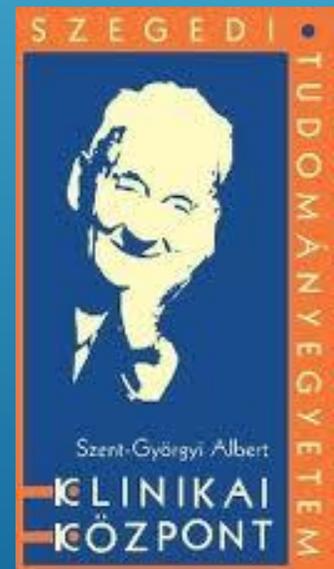
LASERS IN UROLOGY

Mártin Zagorac MD, István Papos MD, Óry-Tóth Csaba MD

University of Szeged

Department of Urology

LAMELIS 2019



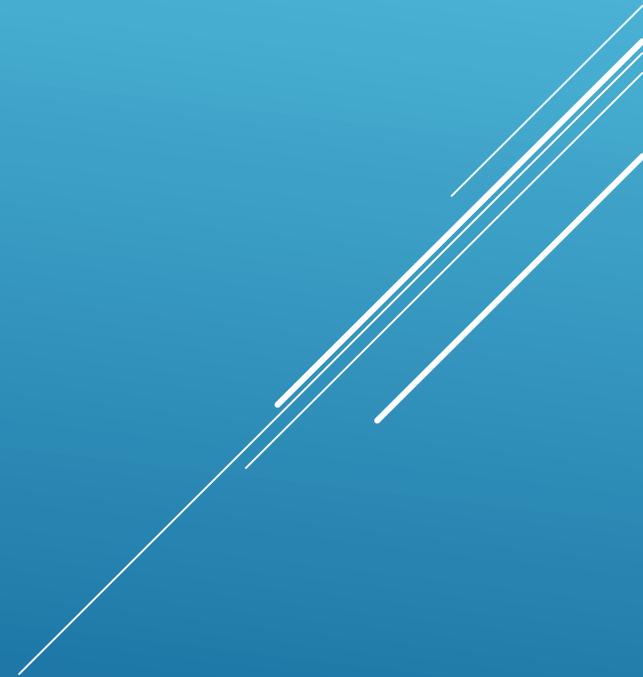
LASERS IN UROLOGY

- ▶ 1960 Maiman visible laser light
- ▶ 1966 Parsons used pulsing ruby laser on canine bladder
- ▶ 1968 Mulvany fragmented urinary stone using ruby laser
- ▶ 1980 CO2 laser for condyloma therapy
- ▶ 1982 pulsed dye laser for urolithiasis
- ▶ 1990: modern era of lasers in urology, application in BPH therapy



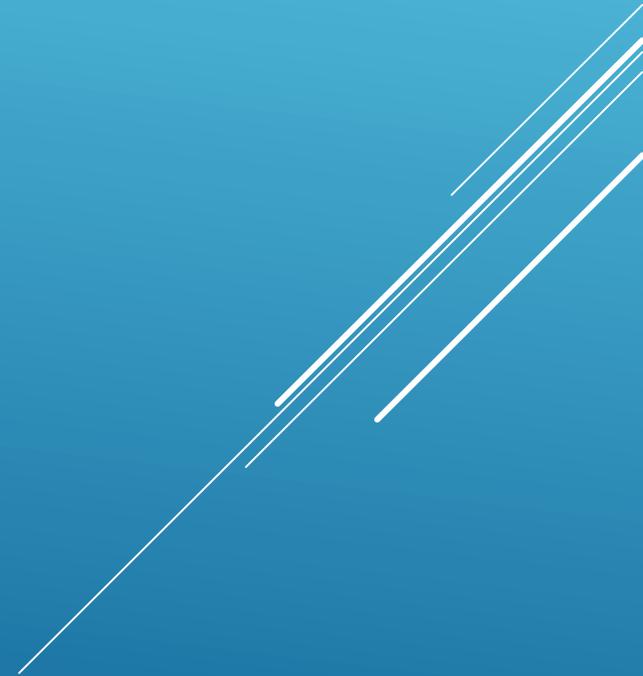
DIFFERENCES BETWEEN LASER AND NATURAL LIGHT

- ▶ **Coherence** (all photons are in one phase)
- ▶ **Collimation** (photons travel parallel with no divergence)
- ▶ **Monochromaticity** (photons have the same wavelength)



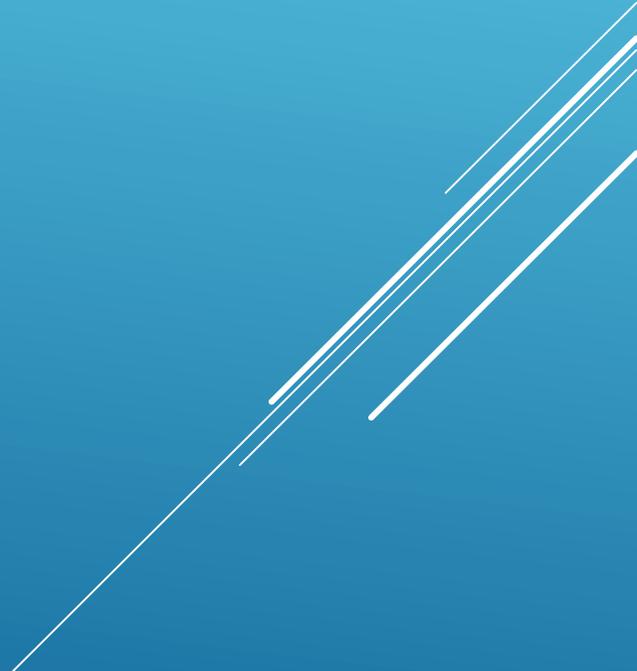
LASER-TISSUE INTERACTIONS

- ▶ Surgeons currently using laser beam 4 different effects
 - ▶ Thermal
 - ▶ Mechanical
 - ▶ Photochemical
 - ▶ Tissue welding effects



LASER-TISSUE INTERACTIONS

▶ **Photothermal effect**

- ▶ The most common utilization, whereby light energy is absorbed and transformed into heat
 - ▶ Coagulation: tissue temperature is less than 100 C
 - ▶ Vaporization: tissue temperature is higher than 100 C
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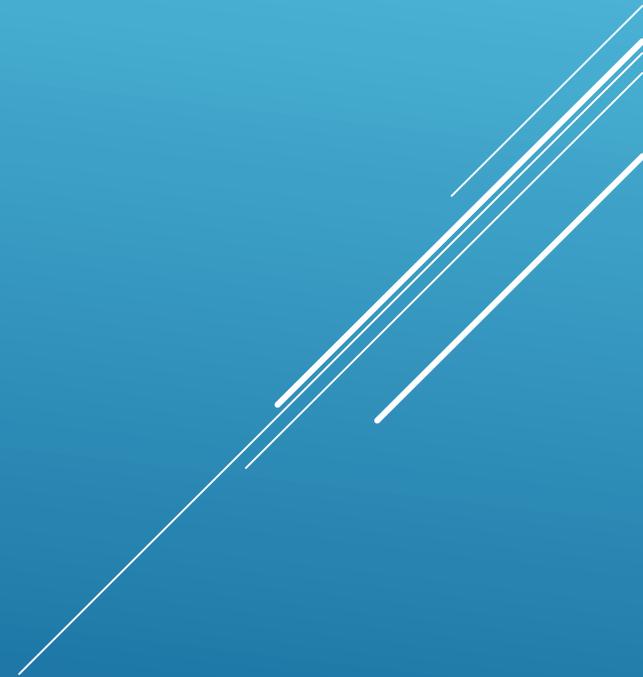
LASER-TISSUE INTERACTIONS

▶ **Photomechanical effect**

- ▶ When a very high power density is directed at an urinary calculus
 - ▶ This creates a plasma bubble that swiftly expands and acts like a a sonic boom to disrupt the stone along stress lines
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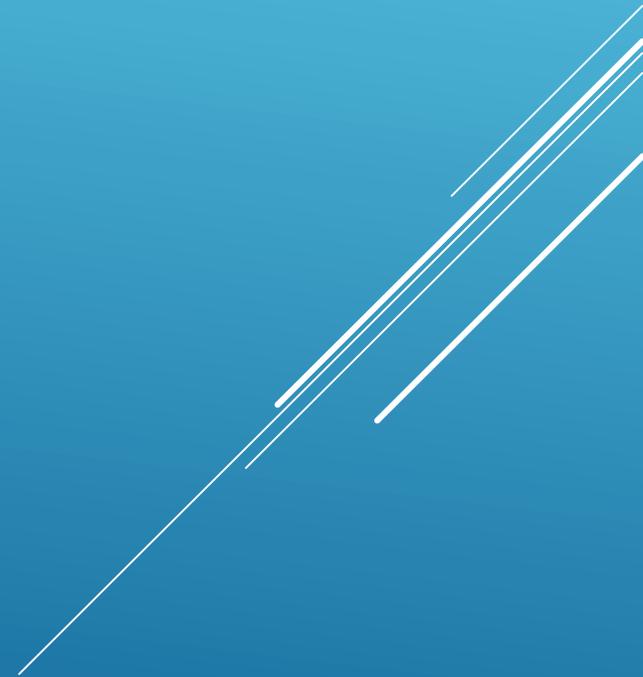
LASER-TISSUE INTERACTIONS

- ▶ **Photochemical effect** refers to the selective activation of a specific drug, which may be administered systemically but is taken up in selected tissues

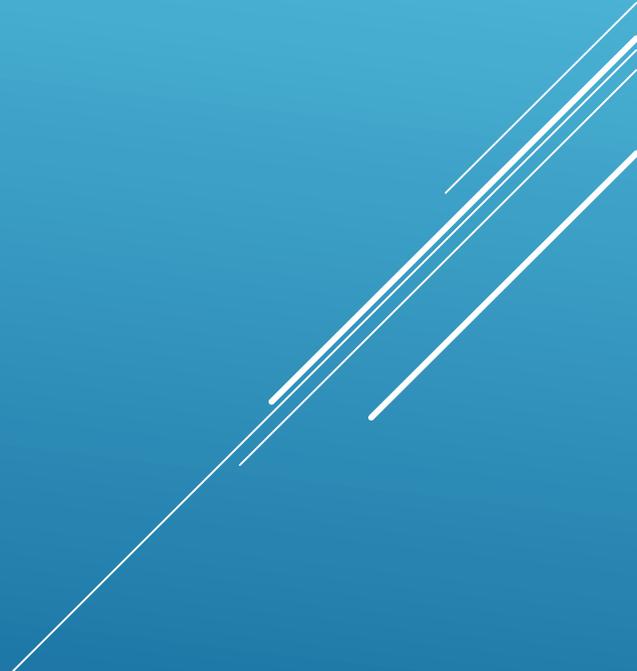


LASER-TISSUE INTERACTIONS

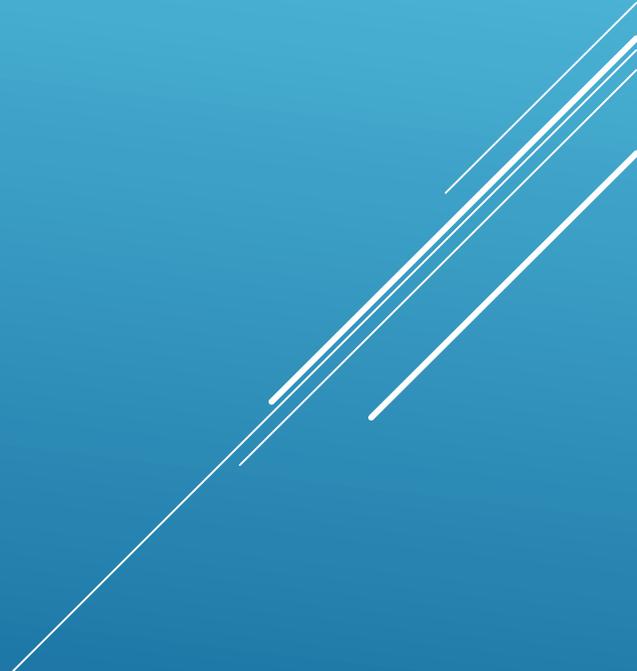
- ▶ **Tissue-welding effect** is derived by focusing light of a particular wavelength to induce collagen crosslinking



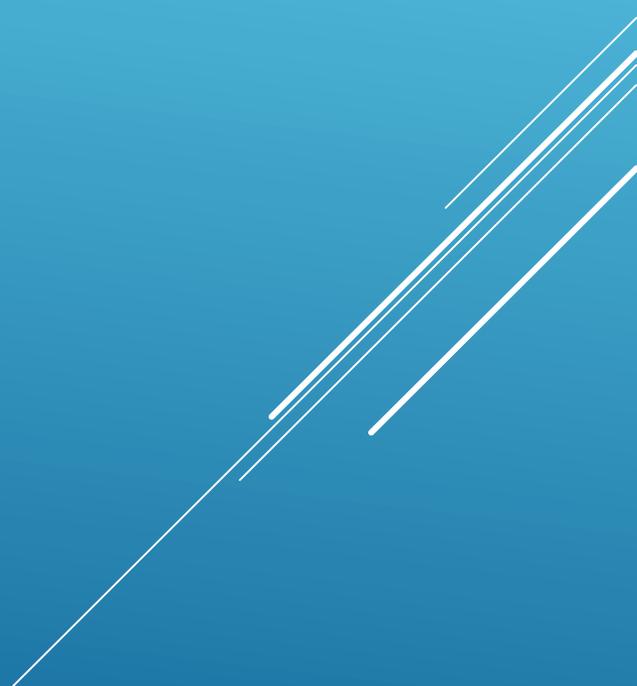
LASER-TISSUE INTERACTIONS

- ▶ Depend on:
 - ▶ The structure of the tissue
 - ▶ Wavelength of the laser
 - ▶ Energy of the laser
 - ▶ Using mode of the laser (pulsing/continuous)
 - ▶ Handling technique of the laser fiber
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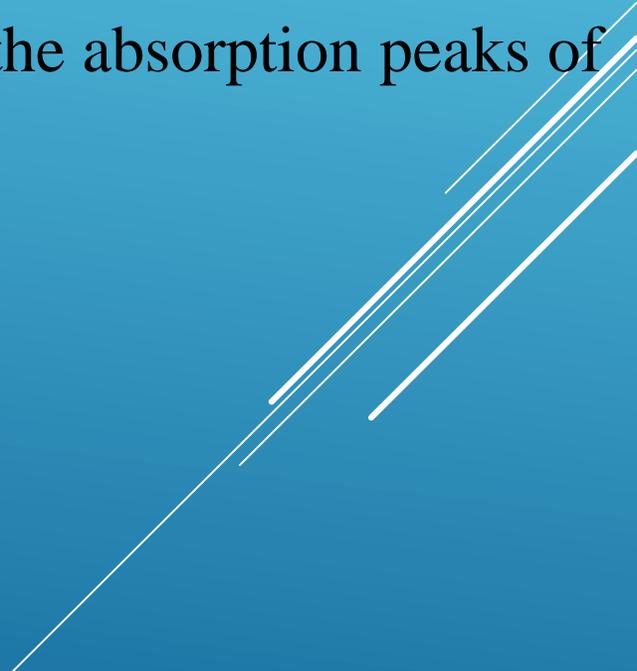
LASER TYPES USING IN UROLOGY

- ▶ Nd:YAG (Neodymium)
 - ▶ KTP:YAG (potassium titanyl phosphate)
 - ▶ Diode lasers
 - ▶ Ho:YAG (Holmium)
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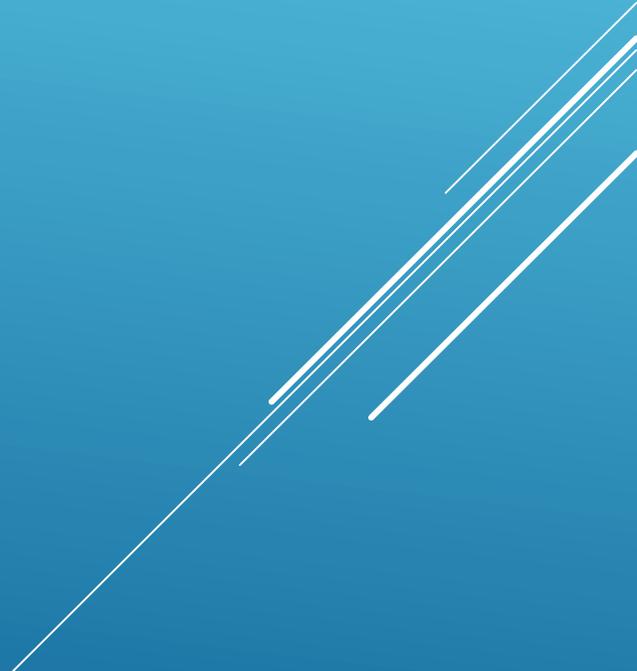
THE TISSUE PENETRATIONS OF THE LASERS

- ▶ Nd YAG: 10 mm
 - ▶ Ho YAG: 0.4 mm
 - ▶ KTP: 0.8 mm
 - ▶ Diode: 5 mm
 - ▶ CO₂: 0.02 mm
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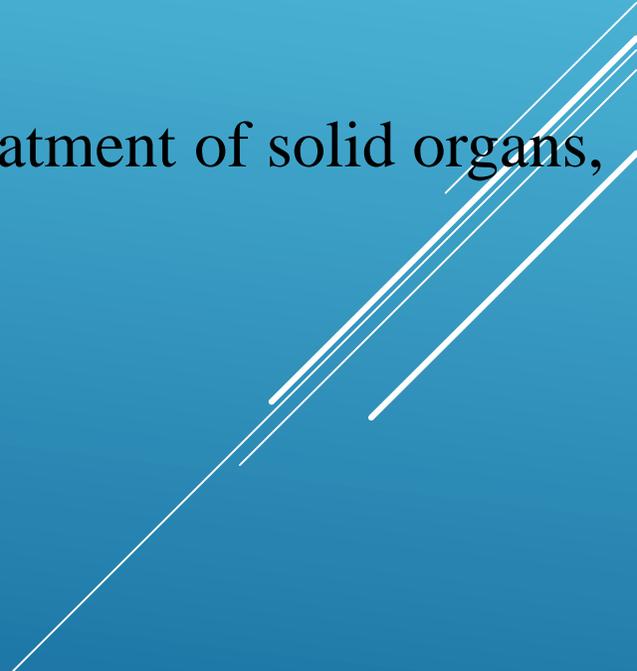
NEODYMIUM: YTTRIUM-ALUMINIUM-GARNET (YAG) LASER

- ▶ Nd:YAG is used commonly today because of its efficiency
 - ▶ Nd:YAG emits a beam at 1064 nm wavelength
 - ▶ Deep penetration. Around 10 mm, because this frequency is outside the absorption peaks of both hemoglobin and water
 - ▶ It has good hemostatic and cutting properties
 - ▶ non-contact „visual ablation of prostate” (VLAP)
 - ▶ Interstitial laser coagulation of prostate (ILC)
- 
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KTP:YAG (GREEN LIGHT LASER)

- ▶ Passing the invisible Nd:YAG beam via a KTP crystals, doubles the frequency and halves the wavelength from 1064 nm to 532 nm
 - ▶ Its energy selective absorbed by haemoglobin, but not by water
 - ▶ Penetration depth is 0.8 mm
 - ▶ Very good coagulation effect (haemostasis)
 - ▶ Noncontact use in prostate vaporisation
- 
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DIODE LASER

- ▶ More efficient and potentially cheaper than most other lasers now in use
 - ▶ Their wavelength can be tuned
 - ▶ These lasers currently are used for tissue coagulation and thermal treatment of solid organs, including the prostate
- 
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HOLMIUM:YAG

- ▶ 2140 nm wavelenght
- ▶ This laser energy is delivered most commonly in a pulsatile manner
- ▶ It superheats water, this creates a vaporization bubble at the probe
- ▶ The vapor bubble expands rapidly and destabilizes the molecules it contacts
- ▶ Depht of penetration in tissue 0.4 mm (therefore the depht of necrosis and thermal damages are limited)
- ▶ Causes rapid coagulation of small vessels
- ▶ Requires contact with the tissue
- ▶ Useful for procedure of prostate, in lithitripsy, ablation of urothelial tumors and for urinary tract strictures

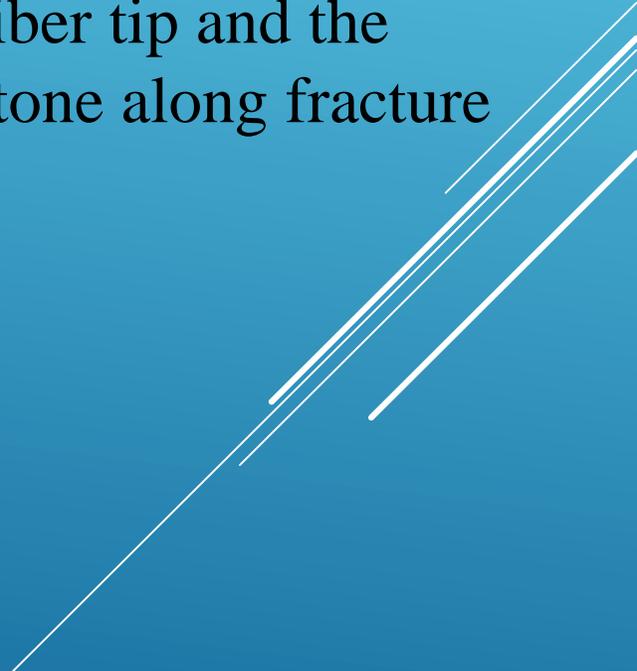
UROLOGICAL APPLICATIONS

- ▶ Open and laparoscopic operations:
 - ▶ Kidney, bladder, ureter, penis, testis
 - ▶ Endoscopic operations
 - ▶ Kidney, bladder, ureter stones
 - ▶ BPH interstitial laser therapy
 - ▶ BPH vaporization, vaporesection, enucleation
 - ▶ Vapoincision of urethral strictures
 - ▶ Bladder tumor, ureter tumor, pyelon tumor vaporizations
 - ▶ Bladder tumor, pyelon tumor fotodynamic therapy (PDT)
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LASERS ON STONES

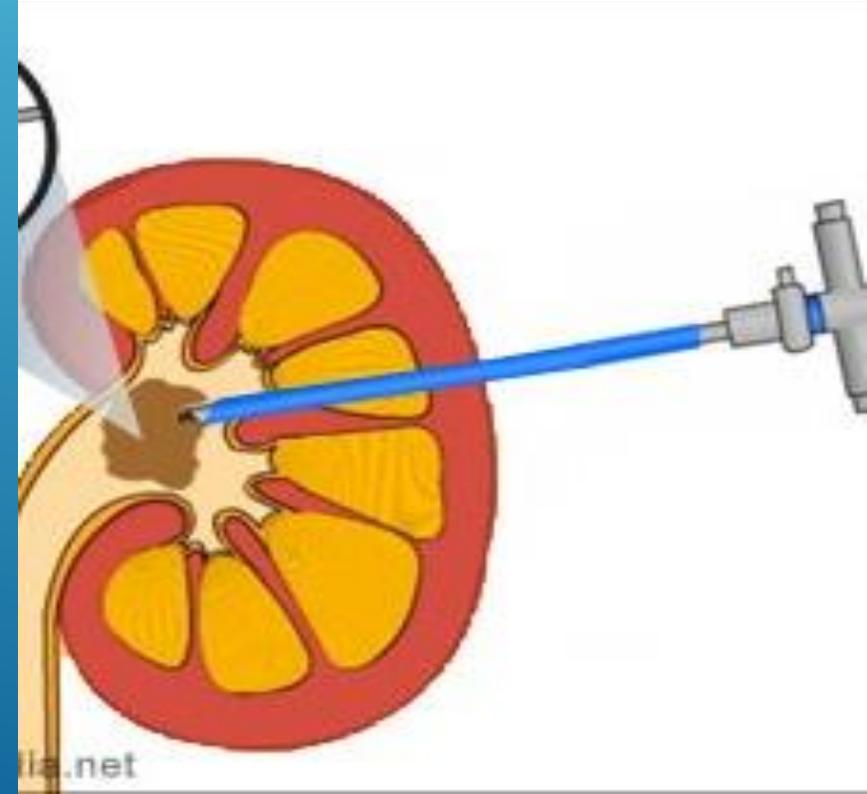
The background is a solid blue gradient. On the right side, there are several white, parallel, diagonal lines that appear to be part of a larger graphic element or a stylized representation of a laser beam or stone surface.

UROLITHIASIS

- ▶ Lasers are ideally suited for either retrograde ureteroscopy or percutaneous nephrolithotomy
 - ▶ The mechanism of action occurs via plasma formation between the fiber tip and the calculus, which develops an acoustic shock wave that disrupts the stone along fracture lines
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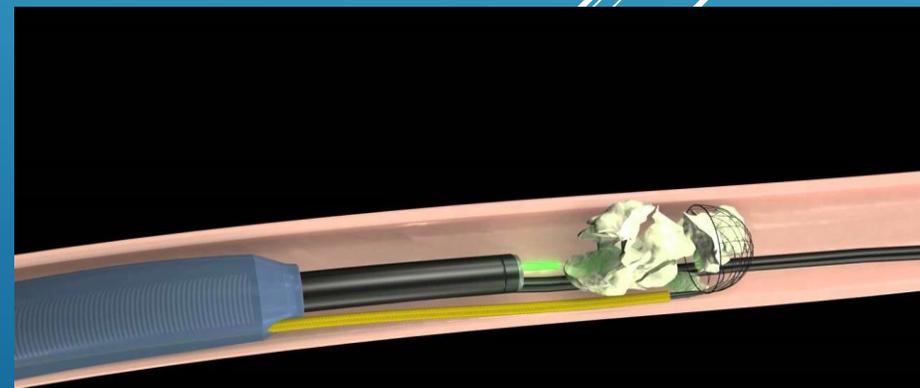
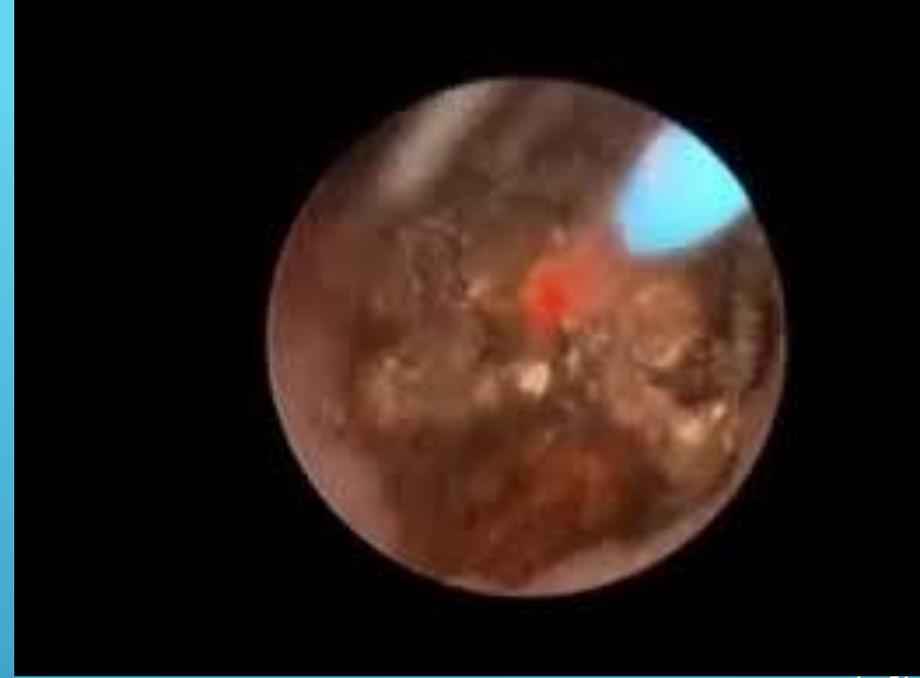
KIDNEY STONES

- ▶ Percutan nephroscopy or/and retrograd pyeloscopy
- ▶ Flexible and rigid instruments
- ▶ Mini PCNL

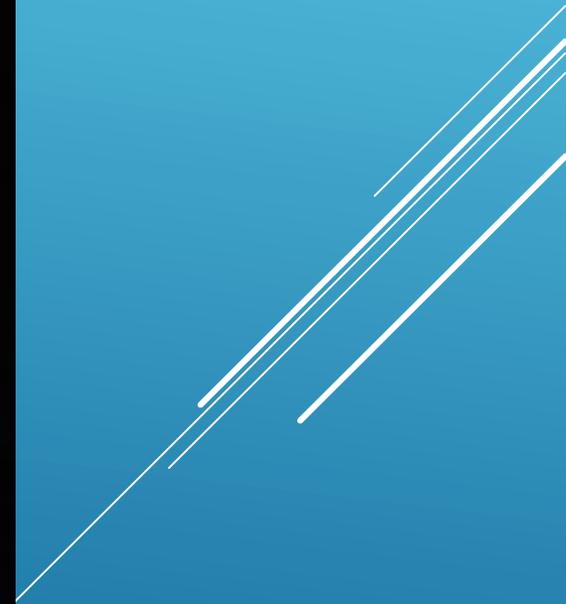
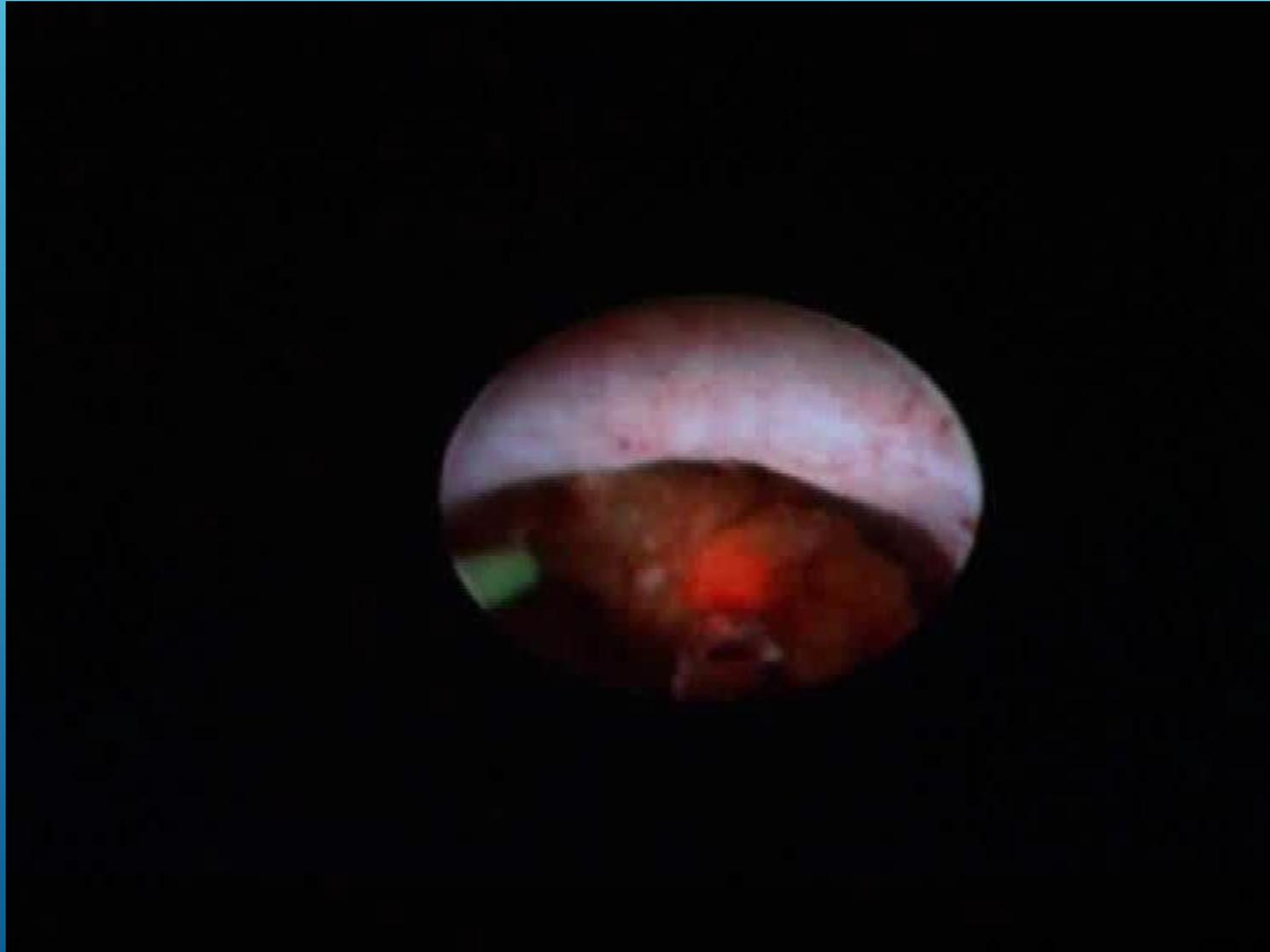


URETER STONES

- ▶ Rigid, semirigid, flexible ureteroscope
- ▶ Thin laser fiber
- ▶ Pulsating holmium or thulium lasers

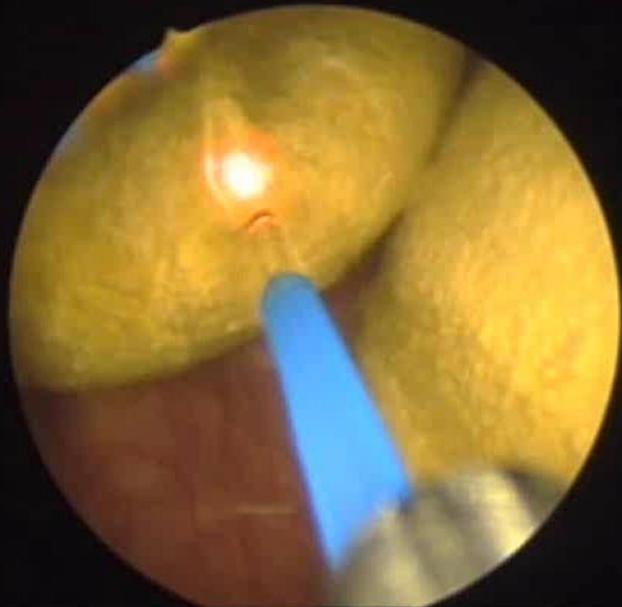


URETER STONES

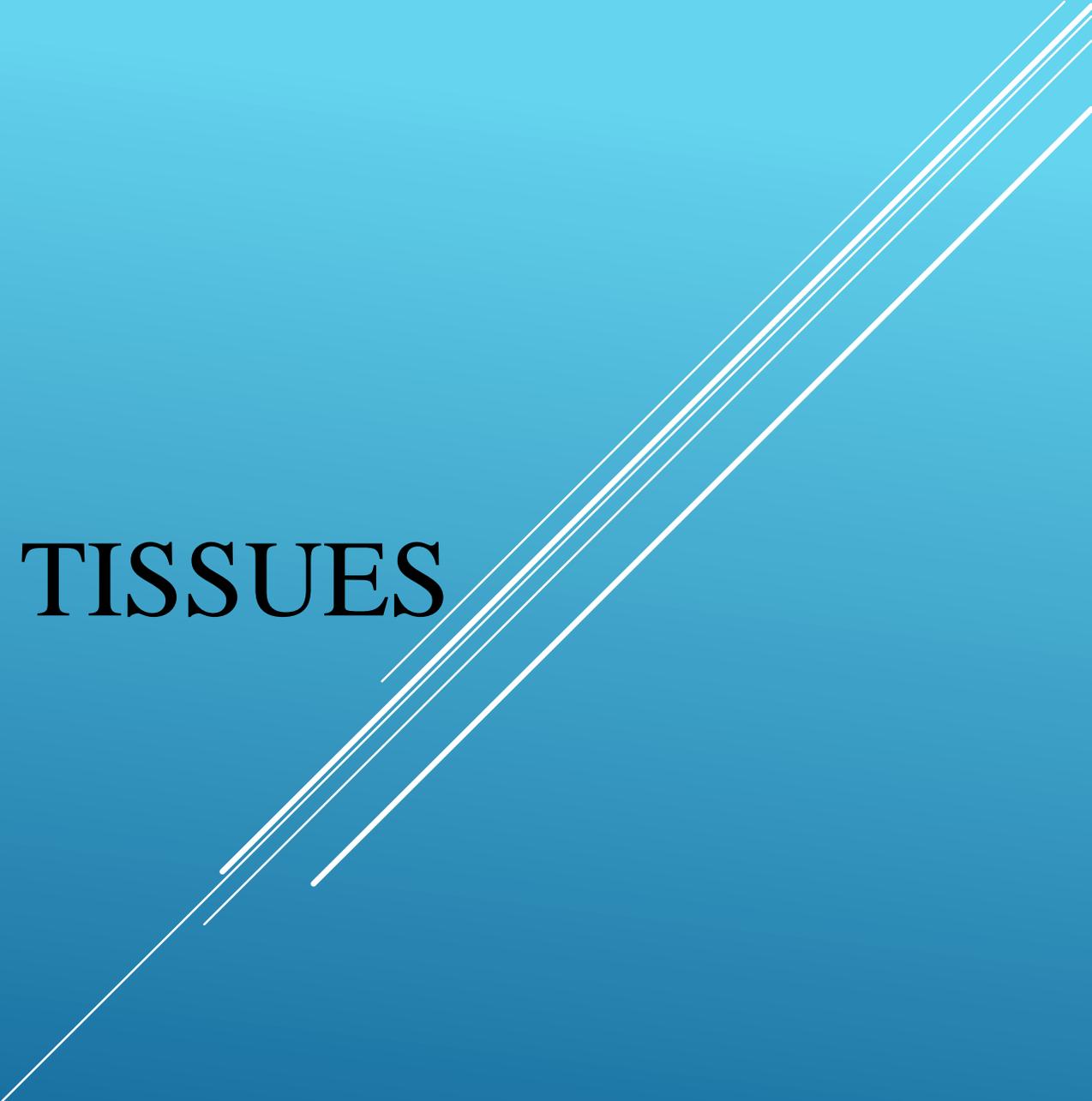


BLADDER STONES

- ▶ Laser cystoscope
- ▶ Larger stones
- ▶ Thicker laser fibers

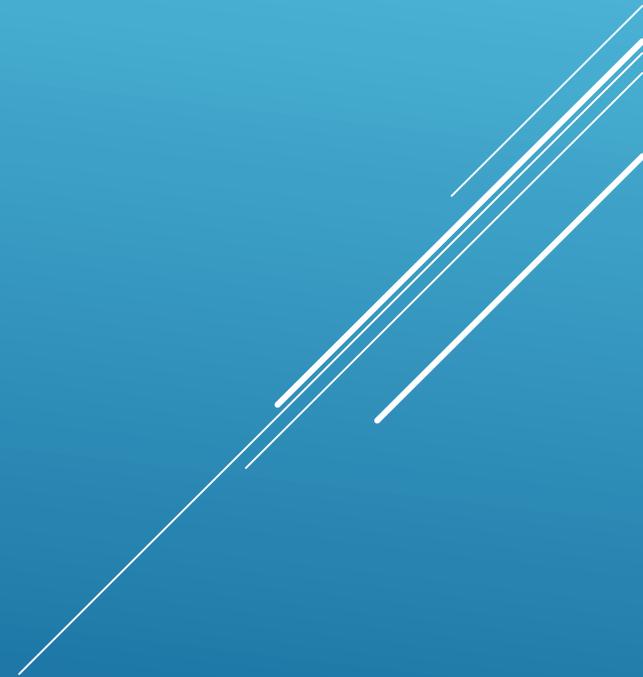


LASERS ON SOFT TISSUES

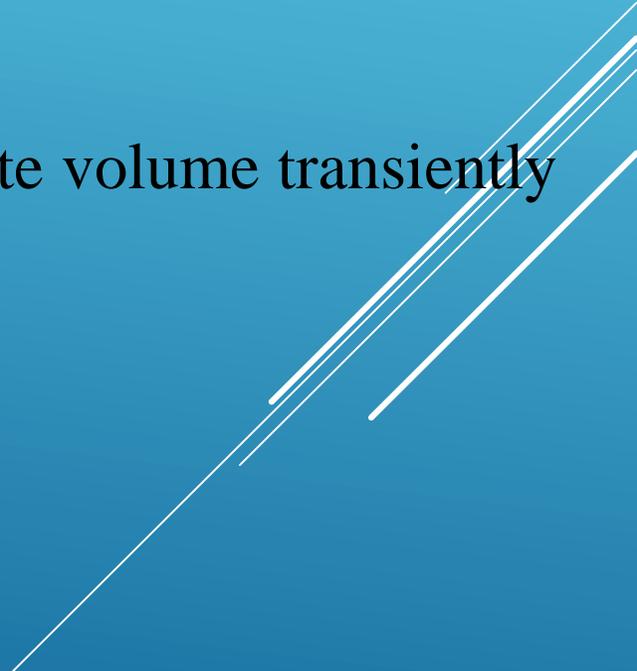
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LASER THERAPY FOR BPH

- ▶ The 2 main tissue effects are
 - ▶ Coagulation
 - ▶ Vaporization



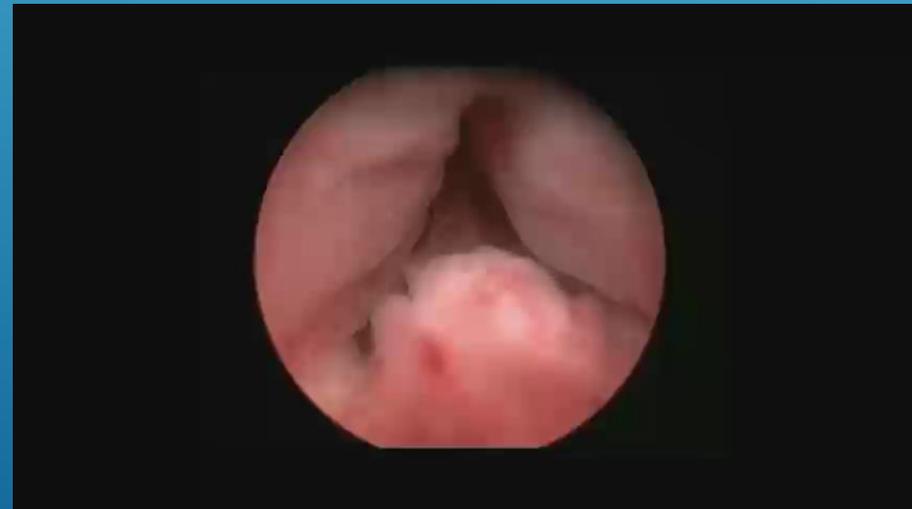
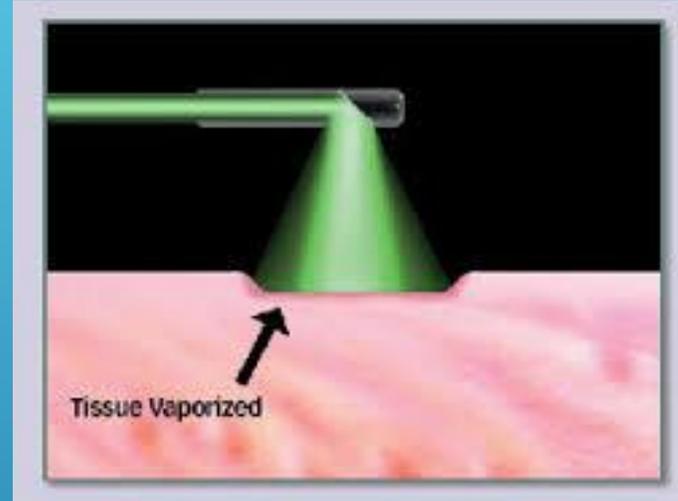
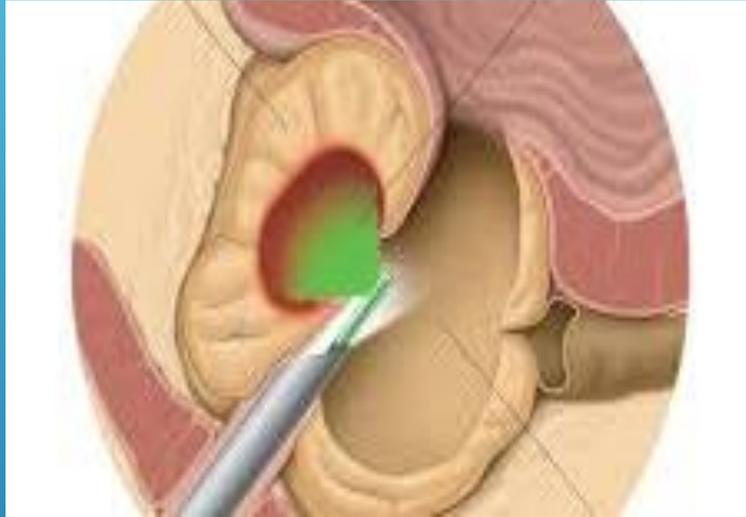
LASER THERAPY FOR BPH

- ▶ **Coagulation** occurs when somewhat diffusely focused laser energy heats tissue to 100 C
 - ▶ Proteins denature and necrosis is developed
 - ▶ This process often initially results in oedema, which increases prostate volume transiently (may require short-term Foley catheter)
- 
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LASER THERAPY FOR BPH

- ▶ **Vaporization** occurs when greater laser energy is focused and tissue temperatures reach as high as 300 C
- ▶ This causes tissue water to vaporize and results in an instantaneous debulking of prostatic tissue
- ▶ The high-power (80 W) KTP laser is commonly used for its vaporization effects
- ▶ This procedure is associated with significantly less bleeding and fluid absorption than standard TURP

PROSTATE VAPORIZATION



APPROPRIATE LASERS FOR PROSTATE VAPORIZATION

- ▶ Nd YAG laser (1064 nm)
 - ▶ Ho YAG laser (2140 nm)
 - ▶ Green light (KTP) laser (532nm)
 - ▶ Diode laser (980 nm)
 - ▶ Those are the most appropriate, which are highly absorbeable in the hemoglobine, and poorly absorbeable in water.
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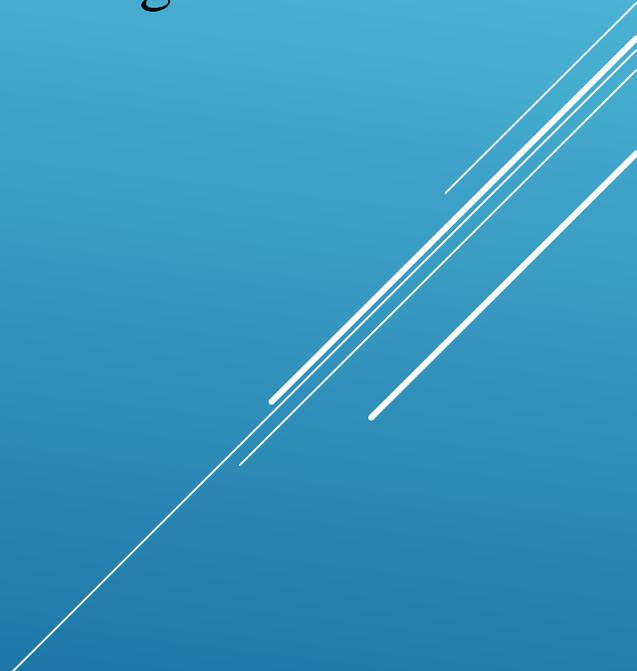
LASER THERAPY FOR BPH

- ▶ The Ho:YAG laser have been used to incise or **enucleate** prostate adenomas down from the capsule
 - ▶ It is ideally suited for this task because it creates precise incisios, cuts by vaporizing tissue with adequate hemostasis, and leaves minimnal collateral damage
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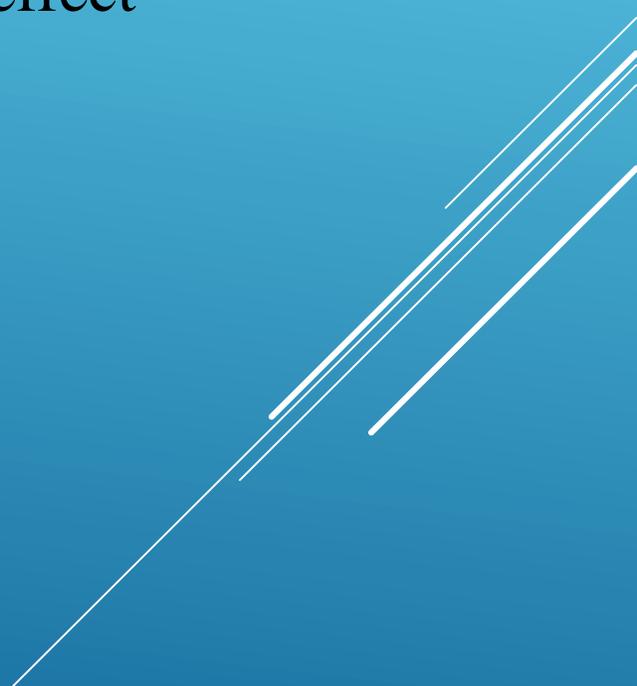
BPH ENUCLEATION



LASER THERAPY FOR BPH

- ▶ Laser modalities are safer than TURP in perioperative period (less bleeding and shorter hospital stay)
- 

LASER TREATMENT OF UROTHELIAL MALIGNANCIES

- ▶ Most commonly Ho:YAG and Nd:YAG are used in this setting
 - ▶ Nd:YAG laser energy is used to coagulate and ablate with a thermal effect
 - ▶ Ho:YAG is more precise with less of coagulative effect
- 
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LASER TREATMENT OF UROTHELIAL MALIGNANCIES

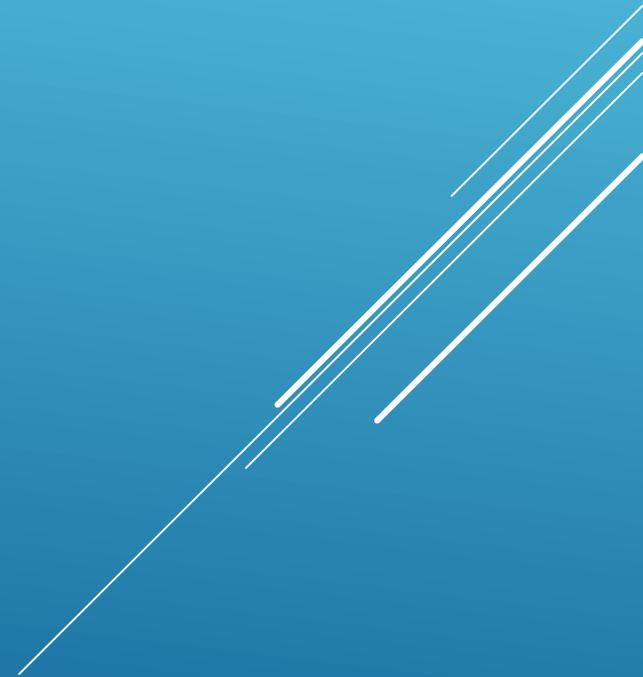
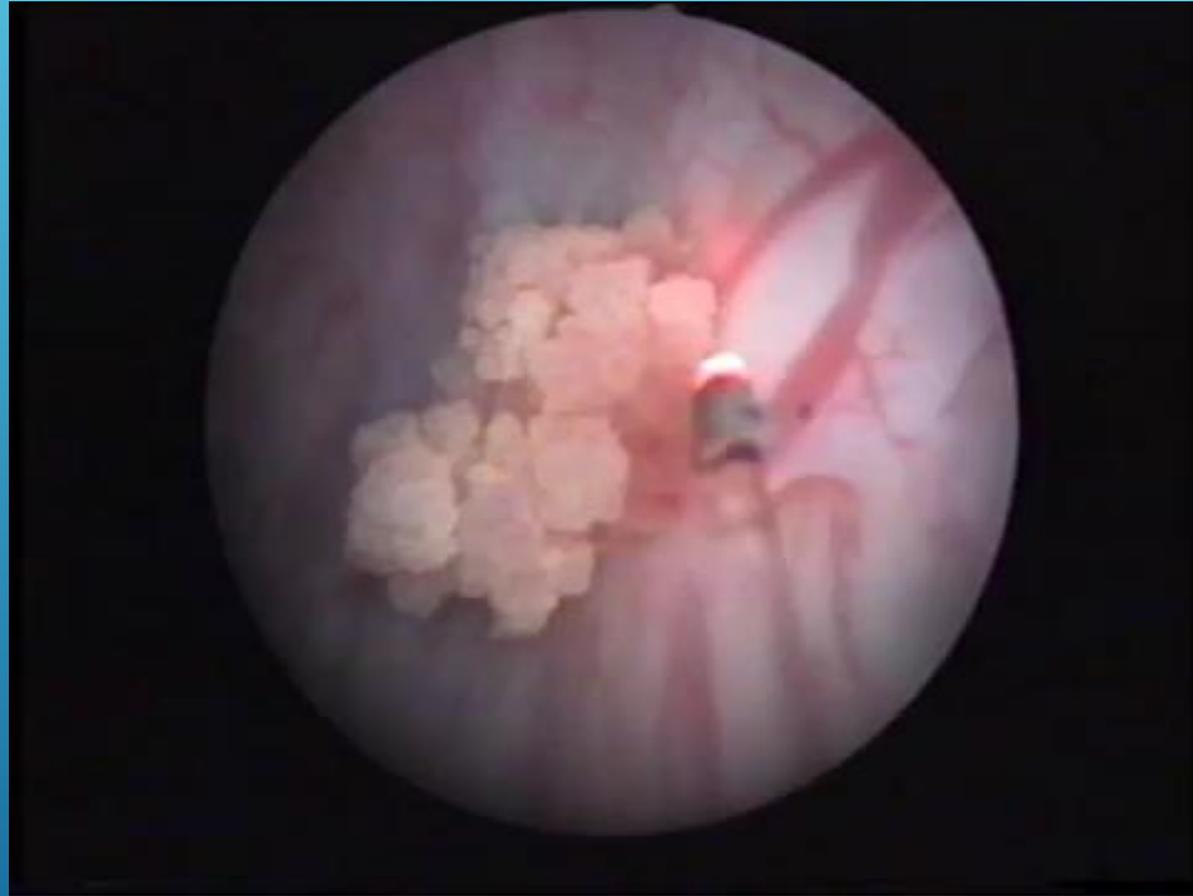
▶ Advantages

- ▶ Less bleeding
- ▶ Lower incidence of stricture formation
- ▶ Less postoperative pain
- ▶ Decreased need for anesthesia

▶ Disadvantages

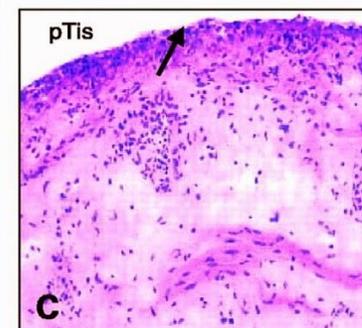
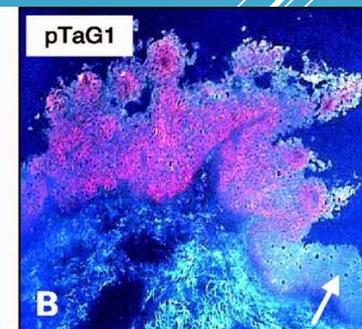
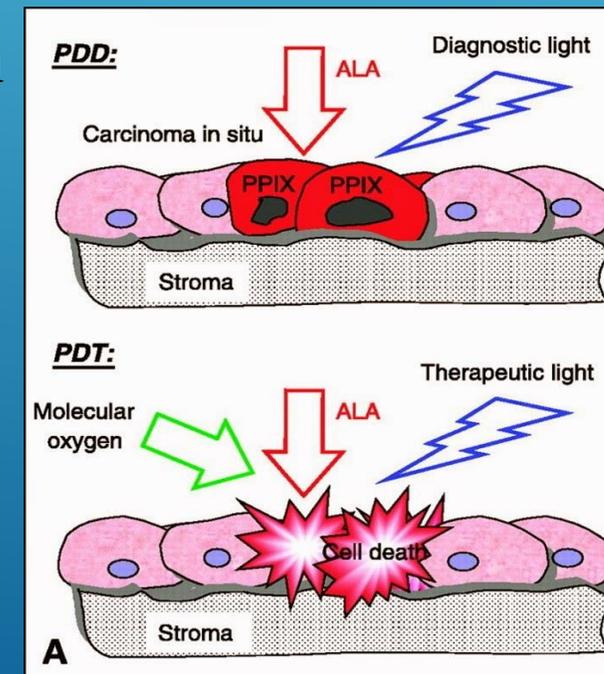
- ▶ No pathology specimen is available (obtain prior biopsy samples)
- ▶ The area of destruction is deep and not fully visualized

LASER TREATMENT OF UROTHELIAL MALIGNANCIES



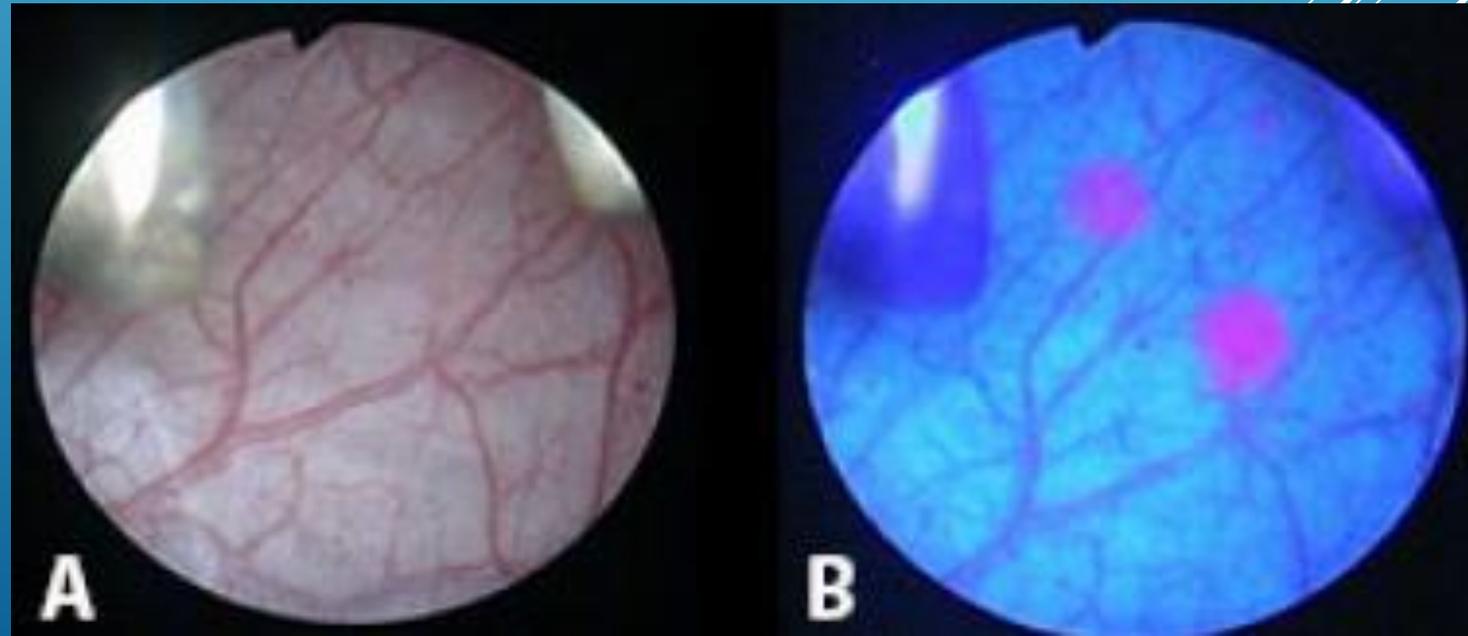
LASER TREATMENT OF UROTHELIAL MALIGNANCIES

- ▶ **Photodynamic therapy** is another form of tumor ablation where systemically administered compound is absorbed by cancer cells and converted by laser light to a toxic compound
- ▶ This compound usually acts through oxygen radicals to destroy malignant cells
- ▶ This is especially promising for TCC-carcinoma in situ



TARGET POPULATION FOR PDT

- ▶ Histologically confirmed high-grade non muscle invasive bladder cancer
- ▶ Considered intolerant/refractory to first-line BCG therapy



LASERS FOR UROTHELIAL STRICTURES

- ▶ Nd:YAG, KTP and Ho:YAG lasers all have been used experimentally to vaporize fibrous strictures of the urethra
- ▶ Ho:YAG is most likely the best type for this task



Treatment
of a
Bulbar Urethral Stricture
using the
Holmium Laser



LASER FOR ABLATION OF SKIN LESIONS

- ▶ Lasers offers minimal scarring and superior cosmetic results compared with other forms of cutaneous lesion resection
 - ▶ Comdyloma acuminata
 - ▶ Penile carcinoma in early stages (Tis,T1,T2)
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THANK YOU FOR YOUR ATTENTION!

