Engineering and Urology Society

32nd Annual Meeting

Friday May 12th, 2017

Boston, MA

http://engineering-urology.org/
The Engineering and Urology Society holds its 32nd Annual Meeting on Friday May 12 in Boston Massachusetts. The mission of the Engineering and Urology Society, a subsection of the Endourological Society, is to promote the development and application of new technology in urology through collaboration between engineers, physicists, and urologists.

Drs Alberto Breda, MD and Martin de Bruijin, MSc, PhD have organized and will co-chair this year’s meeting. Presentations have been structured with a provoker and student challenger to facilitate and enrich discussion and interchange among participants.

Themes of this year’s meeting include application of new imaging modalities for urologic diagnosis and image guided surgical techniques; new technologies for training, patient consultation, surgical planning, and robotic platforms; updates on regenerative medicine and applications of machine learning for personalized medicine. Dr. Mario Parente will deliver the keynote lecture on Hyperspectral Imaging in Medicine.

Two poster sessions in the afternoon provide researchers with the opportunity to present their work and update the attendees on the progress on the field and latest innovations. The review of the abstracts for the poster sessions was performed online by a group of 51 reviewers from around the world. Each paper received between 15 and 20 reviews. We would like to thank the reviewers, listed at the end of this program book, for their essential contribution to the quality of the meeting and their constructive comments that they made for the research.

Based on the review scores, the Society presents the Best Paper Award to paper entitled Nanoparticle Directed Ultra-Focal Laser Ablation of Prostate Tumors from collaborative research groups from New York, NY and Houston, TX. This is listed at the end of this program book, together with the Top 10 abstracts, and Best Reviewer Awards. The authors of all awarded abstracts are invited to submit full length articles to the Journal of Endourology on the respective topics. We gratefully thank all reviewers for their hard work, objective scoring, and contribution to the success of the meeting.

We welcome all urologists, engineers, and scientists to join us for this unique cross-disciplinary experience. As always, we thank Dr. George Nagamatsu the founder and first president of the society, and Dr. Jack Vitenson the first Society Treasurer for setting up the foundations based upon which we meet.

Please visit the website http://engineering-urology.org for a complete version of this program including the abstracts presented.
AUA ACCREDITATION INFORMATION

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- Peer review for valid, evidence-based content of all materials associated with an educational activity by the course/program director, editor, and/or Education Content Review Committee or its subgroup.
- Limit content to evidence with no recommendations
- Introduction of a debate format with an unbiased moderator (point-counterpoint)
- Inclusion of moderated panel discussion
- Publication of a parallel or rebuttal article for an article that is felt to be biased
- Limit equipment representatives to providing logistics and operation support only in procedural demonstrations
- Divestiture of the relationship by faculty

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FACULTY DISCLOSURES:

Atala, Anthony  
Plureon, Inc; Leadership Position

Breda, Alberto  
Cook, Rocamed, Storz, Galil Medical; Meeting Participant or Lecturer, Scientific Study or Trial

Bouma, Brett  
Terumo Corporation; Consultant or Advisor, Scientific Study or Trial, Other, NinePoint Medical; Consultant or Advisor, Other, Heidelberg Engineering; Scientific Study or Trial, Other

Cadeddu, Jeffrey A.  
Titan Medical, Inc; Investment Interest

Harper, Jonathan  
Nothing to disclose

Hawatmeh, Salim I.  
Digital Medical Arts, LLC;

Kavoussi, Louis R.  
In Touch Health; Investment Interest

Laguna Pes, Pilar M.  
Nothing to disclose

Leppert, John Thomas  
Nothing to disclose

Liao, Joseph C.  
Cook, Consultant or Advisor

Liatsikos, Evangelos N.  
Cook Urology; Consultant or Advisor, Meeting Participant or Lecturer

Lima, Estevao  
Nothing to disclose

Menses, Aurus Dourado  
Nothing to disclose

Mottrie, Alexandre  
Intuitive; Meeting Participant or Lecturer

Nakada, Stephen Y.  
Endourological Society; Leadership Position

Pearle, Margaret S.  
Nothing to disclose

Rassweiler, Jens  
Karl Storz Germany; Other

Schulam, Peter G.  
HUMM; Consultant or Advisor

Schulam, Peter F.  
Nothing to disclose

Stoianovici, Dan  
Nothing to disclose

Sweet, Robert  
Department of Defense; Scientific Study or Trial

Traxer, Olivier  
Meeting Participant or Lecturer

Veneziano, Domenico  
Nothing to disclose
EXHIBITORS

**Boston Scientific – Urology**

Boston Scientific is a leading developer of less-invasive medical technologies. Products for the Urology/Women's Health division include devices for the diagnosis and treatment of kidney stones, BPH, female urinary incontinence, and pelvic floor reconstruction. Please visit our exhibit to learn about our newest technologies and our commitment to physician education.

**Cook Medical**

Cook Medical has been a leading supplier of medical devices for urologists for over 35 years. Offering interventional and Biodesign® technologies that support diagnostic and therapeutic procedures in adult and pediatric urology, Cook has placed particular emphasis on stone management as well as both male and female pelvic health.
# 32nd Annual Meeting

**Friday, May 12th, 2017**  
Westin Boston Waterfront  
Harbor Ballroom I & II  
Boston, MA

*Program Chairs:* Alberto Breda and Martijn De Bruin

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Jared Winoker

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11:20 – 11:45am  New Robots Are Coming!  
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12:35pm – 1:00pm  Machine Learning for Personalized Medicine  
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Peter G. Schulam  
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Michael Gorin  
Joseph Liao  

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Ryan Hutchinson  
Jonathan Harper
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ABSTRACT 1

MICRO-COST ANALYSIS DEMONSTRATES COMPARABLE COSTS FOR Lithovue™ VERSUS REUSABLE FLEXIBLE URETEROSCOPE USE

Kazumi Taguchi1,3, MD, PhD, Manint Usawachintachit1,4, MD, David T. Tzou1, MD, Dylan Isaacscon2, MPH, Benjamin A. Sherer1, MD, Ian Metzler1, MD, Marshall L. Stoller1, MD, Thomas Chi1, MD

1 Department of Urology, University of California, San Francisco
2 School of Medicine, University of California, San Francisco
3 Department of Nephro-urology, Nagoya City University Graduate School of Medical Sciences
4 Division of Urology, Faculty of Medicine, King Chulalongkorn Memorial Hospital, Chulalongkorn University

Introduction: Flexible ureteroscopy is a standard approach for treatment of upper urinary tract stones. (PMID:24890883) Reusable ureteroscope durability and need for repair are significant sources of expense and inefficiency for both patients and urologists. (PMID:26542761) Utilization of Lithovue™, a disposable flexible ureteroscope introduced in January 2016, may address some of these concerns. (PMID:27671898)

In this study, we performed a micro-cost comparison analysis between reusable flexible ureteroscopes and Lithovue™ to identify the economic impact of Lithovue™ on clinical care.

Methods: For this prospective, single-center micro-costing study, all consecutive ureteroscopy cases performed during one week in July 2016 and one week in August 2016 utilized either reusable (URF-P6™, Olympus) or disposable (LithoVue™: Boston Scientific) flexible ureteroscopes respectively. During each week, two days of workflow data were collected, including intraoperative, post-operative, and scope cost data. Intraoperative data analysis focused on time differences as well as other clinical parameters between both scopes. Postoperative analysis included reprocessing cycle timing and cost data from the sterile processing and requisition departments. All costs were recalculated as ratios for every dollar spent on labor during disposable flexible ureteroscope cases to protect institutional financial reporting confidentiality.

Results: Intraoperative data analysis showed mean total operating room time for URF-P6™ and LithoVue™ cases were 93.4 ± 32.3 and 77.6 ± 12.8 minutes, respectively (p=0.179). Estimated mean costs of total operating room usage were then calculated relative to labor dollars as $443.49 ± 120.93 for URF-P6™ and $384.31 ± 47.86 for LithoVue™ (p=0.179) based on institutional cost rates. Postoperative data analysis revealed costs of $13.70 and $15.69 for labor and consumables during reprocessing for URF-P6™ cases, respectively. The costs of scope repair and capital acquisition for each URF-P6™ case were $262.39 and $116.02, respectively. LithoVue™ cases were associated with no cost for consumables and repairs. The total ureteroscope cost per case relative to labor dollars for URF-P6™ and LithoVue™ were $767.23 and $765.49, respectively.

Conclusion: Micro-cost analysis revealed the total cost per case for reusable and disposable flexible ureteroscopes were comparable. LithoVue™ may provide significant value in conserving resources for labor, consumables, and repair.
ABSTRACT 2

EVALUATION OF A URETEROPELVIC JUNCTION STENT IN PERCUTANEOUS NPHROLITHOTOMY

Tian C. Zhou¹, Joshua M. Stern²

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Introduction: After standard percutaneous nephrolithotomy a nephrostomy tube can be left to tamponade the tract, decompress the collecting system, and allow for a second-look procedure. Tubeless PCNL is an increasingly popular alternative to reduce post-operative pain and hospitalization time, but even this approach consists of ureteral stent placement leading to significant discomfort. In patients appropriate for tubeless PCNL, we trialed the use of an ureteropelvic junction (UPJ) stent to maintain access while minimizing pain and urinary symptoms.

Methods: 50 patients underwent modified PCNL with UPJ stent left in situ with an extraction string coming out the nephrostomy tract. Patients were selected for UPJ stent if they had proximal ureteral or UPJ edema. The tapered end of a double-J ureteral stent was cut and removed. A string was left attached to the remaining curl and stent inserted anterograde over wire under fluoroscopic guidance with its cut end in the distal ureter and proximal end in renal pelvis (Fig 1). The string was brought out through the tract and pressure held. Patients were considered for UPJ stent if they had no significant bleeding and nephrostogram or ureteroscopic evidence of distal ureteral patency. Primary study endpoints included complications, emergency department visits, or re-admissions. Secondary endpoints were perioperative parameters including mean operative time, blood loss, length of stay, and time to stent removal.

Results: Of 50 patients, 49 were successfully drained by UPJ stent. There were four Clavien grade III complications: one patient required exchange of her UPJ stent with a double-J stent due to distal ureteral clot and three patients required ureteroscopic retrieval of retained stents. Minor issues included three patients with stent discomfort. Patients stayed an average of 1.6±0.5 days, including 15(30%) same day discharges. Mean operating time was 141±17 min, EBL 51±12 cc, and mean stone size was 1.98±0.23 cm in longest dimension.

Conclusion: UPJ stent is a safe and effective modification to PCNL to maintain antegrade access and minimize stent discomfort from the distal stent curl. Further studies should be performed to determine optimal candidate selection and quantify stent-related symptoms.

Figure 1: Ureteropelvic junction stent in situ
ABSTRACT 3

DISPOSABLE RESECTOSCOPE WITH 360° ROTATING LOOP AND INTERNAL DIGITAL CAMERA

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Introduction: Traditional resectoscopes offer limited comfort and precision during anterior prostate and bladder dome resections often requiring surgeons to switch hands or hold the resectoscope upside-down. We evaluated a disposable resectoscope which offers 360° resection while the surgeon's hand remains in a neutral position.

Methods: In a laboratory setting a disposable resectoscope was investigated, Figure 1. The resectoscope was constructed with disposable plastic and supports a familiar removable but rotating outer sheath. The traditional inner sheath is replaced by a fixed-to-the-handle internal tube which houses digital optics and fiber optic light delivery to a distal chip-on-the-tip camera. The handle supports a proximal knob that replaces a camera head attachment and is fixed to a cautery/camera unit which rotates the pair independently of the instrument's handle. All wiring and tubing enters the scope distal to the surgeon’s hand with a cord containment system (CCS) within the handle preventing tangling during rotation. Redundant irrigation ports allow irrigation to enter the scope in the standard dorsal-ventral fashion, or bundled ventrally together. To test feasibility of use nine surgeons participated in an ex-vivo simulation and evaluated the scope based ease of manipulation, comfort, utility of new design, desire to try device in-vivo, and usefulness of disposability.

Results: An internal rotating system allows the loop and camera to revolve 360° while a surgeon’s hand remains comfortably neutral. All wiring is repositioned in front of the handle to free a surgeon’s hand of any physical obstruction during surgery. An internal digital chip-on-the-tip camera eliminated the need for a traditional lens and bulky camera attachment. A relatively wireless surgical field is maintained by a CCS allowing all tubing to remain fixed in a position of choosing while the scope rotates. Surgeons who participated in the ex-vivo simulation gave agreeing responses, with an overall approval rating of 91%.

Conclusion: This device can access 360° of resection comfortably without changing a surgeon’s hand position. A disposable resectoscope has the potential to obviate expenses associated with reusable equipment and eliminates the risk of cross contamination. A continued investigation is warranted.

Figure 1: Disposable Resectoscope
ABSTRACT 4

CREATION OF A PROSTATE PHANTOM FOR MRI/ULTRASOUND FUSION BIOPSY TESTING AND TRAINING

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Introduction: The use of transrectal ultrasound (TRUS) and magnetic resonance imaging (MRI) fusion for targeted prostate biopsies are increasingly used clinically. To our knowledge, a phantom that can be used for imaging fusion and biopsy testing and training does not exist. We sought to create a phantom with favorable imaging characteristics that can be sampled with core biopsies to confirm successful registration of target lesions.

Methods: The prostate phantom was created from an approximately 50 cc clay model and cast from liquid polyvinyl chloride (PVC) into a two-part silicone mold split on the mid-coronal plane. Soft clay lesions were shaped in three sizes (5, 7, 10 mm) and placed at either side of an aluminum (Al) rod, positioned to maintain a urethral lumen. The prostate was then coated with a PVC/Toluidine Blue O mixture \cite{1} in order to gain an echogenic response from the capsule. The body of the phantom was cast into a 4”x4”x6” Al box fitted with an Al rod (1” d x 3” h) to simulate the rectal cavity; the encapsulated prostate was placed ~1cm above the rectal cavity. A DICOM image set was acquired using our multiparametric prostate MRI protocol on a 3T GE MR 750 scanner and fused with TRUS imaging on a GE Logiq E9 with vnav (GE Healthcare, Chicago, IL). Two fellowship trained urologic oncologists performed a biopsy feasibility test using a disposable 18 gauge, 22 cm Bard Monopty core biopsy gun (C.R. Bard, Murray Hill, NJ).

Results: The phantom demonstrated clear contrast between the prostate and target lesions on T2 MRI. The capsule and urethral lumen were both identifiable on TRUS imaging and fusion was possible. Biopsy cores were obtainable and successful biopsies of the target lesions could be confirmed in the core needle without magnification.

Conclusion: We created a simple prostate phantom with desirable imaging properties that can be biopsied with standard clinical equipment. After continued improvement of the phantom, we plan to study its efficacy for fusion biopsy training and for comparative accuracy testing of fusion algorithms and platforms.

![Image](image_url)
LASER TREATMENT OF FEMALE STRESS URINARY INCONTINENCE: PRELIMINARY OPTICAL CHARACTERIZATION STUDIES IN CADAVERS

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Introduction: A minimally invasive laser procedure is being developed as an alternative to surgical sling procedures and radiofrequency thermal remodeling methods for treatment of female stress urinary incontinence (SUI). Experimental studies in porcine vaginal tissues, ex vivo, and computer simulations have been reported, showing feasibility of using near-infrared (IR) laser energy in combination with a transvaginal contact cooling probe to thermally remodel endopelvic fascia, while preserving vaginal wall from thermal insult. The objective of this study is to explore optical properties of human vaginal tissue in a cadaver model as an intermediate step towards future pre-clinical and clinical studies, in vivo.

Methods: Three female cadavers were examined. An ultrasound system with high-frequency (13 MHz) endovaginal probe was used to measure thickness of vaginal wall, endopelvic fascia, and urethral wall. An optical spectrometer measured percent reflectance as a function of time and wavelength in the visible to near-IR spectrum, with and without application of glycerol as an optical clearing agent (OCA). The reflectance spectrum was first collected in the cadaver and then in excised tissue. Optical coherence tomography (OCT) was used to measure the increase in optical penetration depth in the tissue as a function of OCA application time. Thermal lesions were created in the vaginal tissue using a laser at 1075 nm, incident power of 4.6 - 6.4 W, spot diameter of 5.2 mm, and irradiation time of 30 s. Laser energy was delivered through a custom-built transvaginal probe incorporating a flow cell cooled to a temperature of -2 °C for simultaneous cooling of tissue surface through a sapphire window (Figure 1A).

Results: Pre-application of glycerol to the vaginal wall in cadavers resulted in a 15 ± 2% increase in optical transmission at room temperature after 11 min (with calculated increase of 33% at body temperature). An incident laser power of 4.6 W delivered to tissue for 30 s produced a lesion area of 4.6 ± 0.6 mm² with preservation of 1.1 ± 0.2 mm of the tissue surface from thermal insult (Figure 1B).

Conclusion: Optical studies in a cadaver model demonstrated subsurface targeting of endopelvic fascia with partial preservation of vaginal wall, using deeply penetrating near-IR laser energy in combination with contact cooling. OCA application improved optical penetration. Future studies are planned to optimize laser parameters for subsurface thermal remodeling with tissue surface preservation.

Figure 1. (A) Transvaginal laser probe (19 x 22 mm head) with integrated cooling at -2 °C; (B) Subsurface thermal lesion created in female cadaver vaginal tissue using probe with laser wavelength of 1075 nm and incident power of 4.6 W for 30 s.
FEASIBILITY OF AUTOMATING THE MEASUREMENT OF KIDNEY STONE DIAMETER, VOLUME, AND DENSITY FROM CT

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Introduction: Several options exist to estimate renal and ureteral stone burden on CT, including volume, surface area, and maximum diameter. No specific measure is accepted as a gold standard for use in research or clinical care, as calculation of these individual parameters is difficult and time consuming. We developed an automated tool for calculating relevant urinary stone parameters on CT.

Methods: An algorithm was developed to identify stones on CT based on an attenuation threshold within a region of interest (ROI). The program was developed in MATLAB 9.1 (MathWorks, Natick, MA) to perform the entire analysis based on the DICOM image set. A threshold of 250 Hounsfield units (HU) was selected to ensure that the stone remains a single object, while eliminating adjacent soft-tissues. For each image set, a ROI was identified by a board-certified radiologist (Fig. 1AB), and the stone was manually selected in the ROI. Then, the program automatically segmented the stone (Fig. 1C) and calculated the diameter of the smallest sphere that fully encloses the stone and its volume (Fig. 1D), the largest size of the stone in x, y and z directions, their sum, and statistical measures HU values throughout the stone. The actual volume of the stone was also measured by summing the volumes of all voxels within the stone. Images of 18 consecutive patients with a history of nephrolithiasis who underwent a CT from 9/2016-1/2017 were included in the analysis.

Results: Table 1 outlines the calculated parameters for 10 of the 18 total cases, due to space constraints. The correlation between stone volume and sphere volume was 0.807.

<table>
<thead>
<tr>
<th>Stone</th>
<th>Sphere Size [mm]</th>
<th>Stone Vol [mm³]</th>
<th>HU Avg</th>
<th>SD</th>
<th>Max</th>
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<tbody>
<tr>
<td>1</td>
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<td>2</td>
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<tr>
<td>3</td>
<td>15.1</td>
<td>1808.5</td>
<td>9.5</td>
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<td>6</td>
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<td>5719.1</td>
<td>15.0</td>
<td>18.5</td>
<td>16.5</td>
</tr>
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</table>

Conclusion: Automated calculation of clinically relevant urinary stone parameters, such as maximum diameter, and volume can be obtained and visualized at the point-of-care. Measured (sphere) and calculated (actual stone vol) stone volume are moderately correlated, yet differences are likely due to the variability in stone shape. Future investigations will determine how automated stone measurements may aid in clinical outcome prediction.
THE EVALUATION OF ERGONOMY IN ROBOTIC FLEXIBLE URETEROSCOPY VERSUS STANDARD FLEXIBLE URETEROSCOPY

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Introduction: Robotic flexible ureteroscopy using Roboflex Avicenna appears already as a more efficient method than standard flexible ureteroscopy, both in terms of operatory parameters but also as the offered comfort for the urologist. Our aim was to evaluate the ergonomics offered by the robotic device in comparison with the traditional method.

Methods: The study included 64 patients equally randomized, which performed robotic flexible ureteroscopy and flexible ureteroscopy for renal stones between January and December 2016. All procedures have been performed with a Storz flexible ureteroscope SPIES associated with Avicenna Roboflex. The degree of ergonomics was evaluated by the surgeon using a questionnaire already used with success by Saglam et al., with a reference range between 0 (no pain) and 5 (extreme pain).

Results: Overall, regarding musculoskeletal pain, it was recorded a value of 3 compared to 0, for neck pain the score was 4 versus 0, for shoulder stiffness it was 5 versus 2, 5 versus 1 for arm pain, for forearm and elbows pain, there were 3 versus 2 for the hand pain, it was 2 versus 1 for wrist pain and back pain and for pain of the legs, both for FURS and for robotic FURS. As regards the eyes and the finger discomfort, this was similar for both groups. Also, an average value of 32.5 (15-41) was recorded for FURS compared with 6.1 (5-12) for robotic FURS.

Conclusions: Flexible robotic ureteroscopy presents a significantly ergonomics level compared to standard flexible ureteroscopy, thus contributing to a decreasing of the physical effort of the operator.
SPIES VERSUS WHITE LIGHT TECHNOLOGY IN UPPER URINARY TRACT TUMORS’ DIAGNOSTIC – COMPARATIVE EVALUATION


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**Introduction:** The trial was aimed to assess the reliability of SPIES (Storz professional image enhancement system) technology by comparison to white light from the perspective of the diagnosis of upper urinary tract urothelial carcinoma.

**Methods:** A total of 20 UTUC suspected consecutive cases were enrolled in this initial series. The inclusion criteria were represented by hematuria, positive urinary cytology and/or CT/ultrasound suspicion of upper urinary tract tumor. Following the standard white light flexible ureteroscopy (WL-FURS), all patients underwent SPIES (using all 4 available modes) evaluation of the urothelial mucosa using a STORZ XC flexible ureteroscope. The biopsy of suspected areas was performed for all white light visible lesions, while SPIES was distinctively performed for tumors exclusively visible in the respective vision modes.

**Results:** The overall UTUC lesions detection rate was slightly improved for SPIES (95.3%) by comparison to WLC (93.7%). A total of 2 patients were described subsequent SPIES as presenting supplementary tumors when drawing a parallel to classical endoscopy. Two patients were only diagnosed with urothelial cancer by applying SPIES. No significant differences were determined between SPIES and WL regarding UTUC diagnostic accuracy regardless of tumor stage. A total of 6 (3 pTa, 2 pT1 and 1pT2) and respectively 5 (2 pTa and 3 pT1) lesions were discovered using SPIES and WL modes.

**Conclusion:** SPIES was emphasized as presenting an improved UTUC diagnostic accuracy when compared to standard WL. However, a large cohort study is necessary for establishing the right viability of this new method.
ABSTRACT 9

MULTI-INSTITUTIONAL EVALUATION OF QUALITY OF UPPER URINARY TRACT BIOPSY USING BIGOPSY FORCEPS, 2.4F NITINOL BASKET, OR PIRANHA FORCEPS

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Introduction: A number of ureteroscopic biopsy devices have been developed to aid the diagnosis of upper tract urothelial carcinoma (UTUC). The most recent addition is the back-loaded BIGopsy forceps, which was developed in order to extract a greater volume of tissue for histopathological diagnosis. In an effort to compare the BIGopsy forceps to contemporary biopsy devices, a retrospective multi-institutional analysis was performed.

Methods: From 2011-2016, 182 biopsies were performed for suspected UTUC in 145 patients. Specimens were collected using the BIGopsy forceps (Cook Medical, Bloomington, IN, USA), a 2.4F nitinol stone basket (Boston Scientific, Newport Beach, CA, USA), or Piranha biopsy forceps (Boston Scientific, Newport Beach, CA, USA). The lesion’s location was recorded along with the following biopsy characteristics: crush artifact, intact lamina propria, presence of urothelium and concordance between the biopsy and nephroureterectomy specimen. Chi-squared analysis was used to compare objective features of the biopsy specimen obtained by each device.

Results: Patient demographics were similar among the three devices used. With regard to keeping the urothelium intact and avoiding crush artifact, the BIGopsy forceps and basket performed similarly (p=0.186 and p=0.349, respectively) and outperformed the Piranha forceps for intact urothelium (p= 0.004 and p=0.044, respectively) and, for the basket, also crush artifact (p= 0.014). Figure 1 depicts overall performance among the biopsy devices. Table 1 highlights performance specific to papillary or sessile lesions.

Conclusion: With respect to obtaining a biopsy sufficient for diagnosis, the BIGopsy device and nitinol basket performed similarly and outperformed the Piranha forceps.

![Figure 1](image_url): Objective measures of the biopsy specimen collected by each device.

<table>
<thead>
<tr>
<th></th>
<th>Presence of Lamina Propria</th>
<th>Presence of Crush Artifact</th>
<th>Intact Urothelium</th>
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<tr>
<td>Papillary Lesion</td>
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<td></td>
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<tr>
<td>BIGopsy (N=36)</td>
<td>92% vs. 69%</td>
<td>0.024</td>
<td>17% vs. 12%</td>
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<tr>
<td>Basket (N=52)</td>
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<td></td>
<td>0.709</td>
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<tr>
<td>Piranha (N=22)</td>
<td>92% vs. 64%</td>
<td>0.022</td>
<td>17% vs. 14%</td>
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<tr>
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<td></td>
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<tr>
<td>Sessile Lesion</td>
<td></td>
<td></td>
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<tr>
<td>BIGopsy (N=18)</td>
<td>94% vs. 78%</td>
<td>0.284</td>
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<td>Basket (N=9) vs.</td>
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![Table 1](table_url): Performance comparison for papillary and sessile lesions.
ABSTRACT 10

HOLMIUM-YAG LASER: IMPACT OF PULSE ENERGY AND FREQUENCY ON LOCAL FLUID TEMPERATURE

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Introduction and objective: During laser lithotripsy energy is transmitted to both the stone and the surrounding fluid. As the energy is delivered the temperature will rise. Temperatures \(\geq 60^\circ\text{C}\) can cause protein denaturation. The objective of this study is to determine the time it takes from body temperature (37\(^{\circ}\text{C}\)) to 60\(^{\circ}\text{C}\) at various laser power settings.

Materials and Method: A Flexiva TracTip 200 optical fiber was submerged alongside a NTC-type thermistor in 4 mL of saline in a glass test tube. A Lumenis VersaPulse Powersuite 100W laser was activated at 0.2 – 1.5 J pulse energies, 6 – 50 Hz frequencies, and 2 – 22.5 W power. Temperature readings were recorded every second from 37 until 60\(^{\circ}\text{C}\). Time and heating rate were measured. The procedure was repeated three times for each setting.

Results: Average time from 37 to 60\(^{\circ}\text{C}\) for settings (1) 0.2J / 50Hz, (2) 0.6J / 6Hz, (3) 1J / 10Hz, and (4) 1.5J / 10Hz was 60.3, 172.7, 58, and 43.3 seconds, respectively. Time from 37 to 60\(^{\circ}\text{C}\) decreased as frequency increased for every given pulse energy. Average heating rate increased proportionally to power from 0.07 to 0.76\(^{\circ}\text{C/second}\).

Conclusion: During laser lithotripsy there is a rapid increase in the temperature of its surrounding fluid and temperatures \(\geq 60\ ^{\circ}\text{C}\) may be reached. This could have local tissue effects and some caution with higher power settings should be employed especially where irrigation is limited. Further studies incorporating irrigation and live tissue models may aid to further define the risks.
DEVELOPMENT OF SOFTWARE TO OVERLAY IMAGING DATA IN REAL TIME ONTO THE INTRAOPERATIVE VIEW DURING ROBOTIC SURGERY

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Robotics Laboratory, Department of Urology, Johns Hopkins University School of Medicine

Introduction: Imaging with CT, MRI, and PET/CT are commonly performed ahead of urologic surgery. The ability to superimpose imaging data in real time onto the intraoperative view during robotic surgery may augment situational awareness and lead to improved patient outcomes. We developed software for this purpose and report its spatial accuracy after in vitro experimentation.

Methods: Calibration of the stereoscopic cameras of a robotic laparoscope is required to overlay cross-sectional imaging data onto the camera view. This includes the identification of the intrinsic parameters of the left and right cameras of the laparoscope (focal length, image centers, etc.) and the transformation between the two camera spaces (stereo camera calibration). The parameters are identified by recording and processing images of a checkerboard [1]. The image acquisition and processing software was developed in Visual C++ using a public domain visualization toolkit (VTK [2]). This part of the software is used to display in real time the laparoscopic images in camera space (CS). A mockup that includes a model of the pelvic bones and an in situ prostate were built. The prostate model was 3D printed and included 13 spherical ceramic markers (Ø4.76 mm) on its anterior-superior surface (Fig. 1). The mockup was imaged with CT and its boney surface as well as the prostate volume were segmented. A Precision Optics stereo laparoscope and Dyonics ED-3 stereo camera were used in the experiments. The centers of the spherical markers on the prostate model were automatically detected in the left and right laparoscopic images using the Hough transform [3], and their 3D positions in the CS were calculated. The same markers were automatically segmented from the CT images in model space (MS) with an isosurface extraction algorithm. The centers of the markers in the CS and MS were used to register the two spaces using Horn’s point-cloud registration method [4]. To overlay the CS and MS images, their registration was performed with a 3-point registration technique [5]. Here, three pairs of corresponding landmarks in the CS and MS images are selected and used to estimate the laparoscope position relative to the CT images by solving a Perspective-n-Point (PnP) problem [6]. In the experiments, the registration was performed using landmarks on the pelvic bones selected by a urologist, and the accuracy was verified on the markers of the prostate (Fig. 2). The experiment was performed 30 times. In all experiments, the error was measured as the distance between the centers of homologous CS and MS spherical markers. The accuracy and precision were calculated as the average and standard deviation of the errors, as usual.

Results: The laparoscope measured the 3D location of the markers with an accuracy and precision of 0.85mm and 0.69mm, respectively. The accuracy and precision of the image overlay were 4.21mm and 2.31mm, respectively.

Conclusion: The developed software allowed for the registration of CT images to the stereoscopic camera view with a fairly high degree of accuracy. In vivo experiments are required to determine the potential for clinical translation.

Figure 1: Experimental setup
Figure 2: Images overlays and error measurements
IN VIVO BIODISTRIBUTION AND TOXICITY OF INTRAVESICALLY ADMINISTERED QUANTUM DOTS FOR OPTICAL IMAGING OF BLADDER CANCER

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Introduction: Optical molecular imaging holds the potential to improve cancer diagnosis. Fluorescent nanoparticles such as quantum dots (QD) offer superior optical characteristics compared to conventional organic dyes, but their in vivo systemic application is limited by potential toxicity related to the heavy metal core (e.g. cadmium, Cd). Topical administration provides an attractive route for the application of targeted nanoparticles with the possibility of minimizing exposure. Previously, we demonstrated successful ex vivo endoscopic imaging of human bladder cancer by intravesical administration of QD-conjugated anti-CD47 antibody [1]. Herein we investigate in vivo biodistribution and toxicity of intravesically instilled free QD and anti-CD47-QD in mice.

Methods: With approval from Stanford Administrative Panel on Laboratory Animal, female C57BL/6 mice were catheterized transurethrally under anesthesia with a 24G angiocatheter. Fifty microliter of PBS, QD, or anti-CD47-QD was instilled for 30 minutes. In vivo biodistribution of anti-CD47-QD was assessed (n=29) with inductively coupled plasma mass spectrometry (ICP-MS). Local and systemic toxicity (n=79) was assessed using standard blood tests, organ weights, and histological examination.

Results: On average, there was no significant accumulation of QD outside of the bladder among untreated, 0-, 4-, and 24-hour groups. Although in some mice we detected widespread QD biodistribution suggesting a route for systemic exposure under some conditions (Figure 1). There were no indications of acute toxicity in blood test up to 7 days after instillation (AST, ALT, WBC, RBC, Hb, BUN, or Cr). Histology of harvested organs was normal except the presence of inflammatory cells in the renal pelvis of 5 of the 19 QD-instilled mice.

Conclusion: Intravesical administration of targeted nanoparticles can reduce systemic exposure, however for clinical use, nanoparticles with good biosafety profiles should be used to decrease long-term toxicity in cases where systemic exposure occurs.

Figure 1: Biodistribution of Cadmium (Cd) in blood and whole organs using ICP-MS. Tissues were harvested from untreated and treated (0-, 1-, 4-, and 24-hr post intravesical instillation of anti-CD47-QD) mice. **denotes statistically significant difference
NANOPARTICLE DIRECTED ULTRA-FOCAL LASER ABLATION OF PROSTATE TUMORS

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Introduction: Various targeted therapies have been developed and evaluated, however these treatments focus energy at a region of the prostate as opposed to directly at the tumor. Gold nanoparticle (GNP) therapy is a novel treatment that results in tumor-specific ablation, sparing surrounding tissue and structures. Herein, we report the first two cases in the world using GNP-directed focal laser ablation of prostate tumors using ultrasound (US) and MR/US fusion technology.

Methods: Patients were enrolled in a phase II trial, ‘A Study of MRI/US Fusion Imaging and Biopsy in Combination with Nanoparticle Directed Focal Therapy for Ablation of Prostate Tissue.’ Treatment and follow up plan are as follows: intravenous infusion on day 0, allowing GNP deposition into the tumors with the goal of achieving a 15.2 µg/cc tumor concentration required for excitation/ablation. On day 1, the patient presents for focal laser excitation of the GNPs. Laser catheters are placed using a combination of US and a transperineal electromagnetic-tracked MR/US fusion device (UroNav). At 48 hours post-ablation, the patient is imaged, followed by re-imaging and MR/US fusion guided biopsy (FBx) at 3 months. All patient demographics, clinical variables, and complications were recorded.

Results: To date, two patients have been enrolled in the trial, both with localized Gleason 7 PCa diagnosed using MR/US FBx. Mean age was 67 ± 4.3 years and mean prostate specific antigen (PSA) was 6.1 ± 0.06 ng/ml. Mean tumor volume was 0.40 ± 0.05 cc with a solitary lesion in each patient. Mean PSA decrease was 2.03 ng/ml, a 33.4% decrease in PSA at 6 months. No short-term complications were observed.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Index lesion pathology</th>
<th>Pathology at 3 months follow up</th>
<th>Initial PSA</th>
<th>PSA at 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3+4</td>
<td>No residual tumor</td>
<td>6.15</td>
<td>4.99</td>
</tr>
<tr>
<td>2</td>
<td>3+4</td>
<td>Microfocus of 3+3</td>
<td>6.06</td>
<td>3.16</td>
</tr>
</tbody>
</table>

Table 1. Summary of 2 patients who underwent GNP-directed ablation

Conclusion: Increasing interest in image guidance technologies and focal therapies has sparked a new generation of PCa treatment modalities. We have demonstrated the first safe and effective use of ultra-focal therapy using MR/US fusion technology in concert with GNP-directed therapy to treat prostate tumors.

Acknowledgments: Invivo, Gainesville, FL; Nanospectra Biosciences, Inc, TX

Figure 1. (a) UroNav generated model for prostate and tumor localization in left apical peripheral zone. (b) Laser catheter (yellow) and thermocouple (blue) insertion pattern viewed from perineum. (c) Optimal wavelength (810nm) for exogenous absorption of energy by gold nanoparticles within tumor.
ABSTRACT 14

THE IMPACT OF FORCES APPLIED DURING URETERAL ACCESS SHEATH DEPLOYMENT ON URETERAL INJURY IN A PORCINE MODEL

Kamaljit S. Kaler¹, Roshan M. Patel¹, Renai Yoon¹, Daniel Lama¹, Shoaib Safiullah¹, Christina Hwang¹, Zhamshid Okhunov¹, Michael Klopfer², Jaime Landman¹, Ralph V. Clayman¹

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Introduction: Widespread use of the ureteral access sheath (UAS) during ureteroscopy has been slowed by concerns over possible ureteral injury during its passage. In this pilot, porcine study, using a novel device developed at UC Irvine, we evaluated the force threshold which would induce ureteral injury.

Methods: With IACUC approval, we measured UAS deployment force using a novel Ureteral Access Sheath Force Sensor (UC Irvine Force Sensor) in a female Yorkshire pig. (Figure 1). Under fluoroscopic control, force was continuously measured from the time the UAS contacted the urethral meatus until the tip of the UAS had reached the renal pelvis. Ureteral dilators (6-9F), UAS and its obturators (9.5F, 10F, 11F, 11.5F, 12F, 13F, 14F, 15F, 16F) sequentially passed twice into both ureters. Ureteroscopic evaluation was initiated after the 9.5F UAS obturator was passed.

Results: No ureteral injury occurred at ≤4 Newtons (N). Increasing UAS size resulted in greater force over-time and larger peak forces (Figure 2). First ureteral injury occurred at 8 N (right ureter) and 10 N (left ureter). Figure 3 shows a normal right ureter before and after deployment of a 13F UAS with a peak force of 8N.

Conclusion: The UC Irvine Force Sensor can reliably measure force while deploying a UAS. Initial ureteral injury occurred at forces ≥ 8 N.

![Image](image1.png)

Figure 1: Ureteral Access Sheath Force Sensor.
A. Top View B. Side View C. Device in practice with the sidearm pressed against the back end of an 8F dilator.

![Image](image2.png)

Figure 2: Force Measurements during Ureteral Access Sheath Deployment (Right ureter)

![Image](image3.png)

Figure 3: A. Normal Right Proximal Ureter; B. Initial Medial Wall Injury in Proximal Right Ureter and with 13F UAS at peak pressure of 8 N ; C. Additional Lateral Wall Injury in the same Proximal Right Ureter with 14F UAS and peak pressure of 7.7 N.
ABSTRACT 15

THREE-DIMENSIONAL KIDNEY MODEL DEVELOPMENT FOR VIRTUAL REALITY

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Introduction: Preoperative imaging is the cornerstone of a well-planned, safe surgical procedure. Advancements in three-dimensional (3D) medical imaging technology have allowed for improved understanding of complex patient anatomy. Virtual reality (VR) technology has similarly improved to the extent that it may become an adjunctive tool in surgical planning and education. We report our initial experience on the feasibility of developing 3D-reconstructed virtual kidney models with subsequent use in a VR environment.

Methods: Medical imaging processing software (3D Slicer, www.slicer.org) was used to convert 64-slice serial axial CT images of 5 patients with small renal mass (SRM) into a 3D computer-aided design (CAD) of the patient’s mass and renal anatomy. Post-processing was performed using 3D software (Blender). The 3D files were subsequently imported to a novel VR software (Bosc, Pear Medical, Seattle, WA) to view and interact with the VR kidney models through a commercially available head-mounted display (HMD). The CT images and corresponding VR models were then reviewed in randomized order by 3 medical students (DL and two nonauthors). An imaging questionnaire was administered after reviewing the CT and again after the VR model. Reviewers were asked to score (0 - 10 scale) their understanding of the SRM’s relationship to various renal structures (e.g. vasculature, hilum, ureter), and to record the location of the SRM. Concordance between location of the SRM noted on the radiology report and the reviewer’s response was recorded.

Results: A steep learning curve was associated with use of the image processing software to recreate individual patient anatomy; mean time for model creation was 220.8 minutes (range 177 - 271). Conversely, importation of the CAD files into Bosc® was seamless. With the medical students wearing the HMD, the kidney models and associated structures could be manipulated in VR using the students’ own hands as input. In addition, the VR kidney model could be cleanly separated from the renal vasculature and the collecting system (Table 1). Although not statistically significant, the VR models tended to improve the user’s ability to give the correct location of the SRM compared to CT alone (concordance: 83% vs. 53%, respectively, p=0.371).

Conclusion: VR technology can be used to view and manipulate a virtual 3D kidney model. Use of VR technology tended to improve the student’s ability to understand the location of the small renal mass and its relationship to the underlying renal structures.

Table 1: Imaging Assessment Questionnaire Responses for 3D Model Rendering

<table>
<thead>
<tr>
<th>Questions</th>
<th>CT Score (n=12) (range)</th>
<th>VR Score (n=12) (range)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>How well do you understand the relationship between the renal mass and the following structures? Arterial/venous (Median)</td>
<td>5 (0-7)</td>
<td>9 (7-10)</td>
<td>0.001</td>
</tr>
<tr>
<td>Venous vasculature (Median)</td>
<td>5 (0-9)</td>
<td>9.5 (8-10)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Venous vasculature (Median)</td>
<td>5 (0-9)</td>
<td>9.5 (8-10)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Hilar anatomy (Median)</td>
<td>5 (0-9)</td>
<td>10 (5-10)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Intrarenal collecting system (Median)</td>
<td>5 (0-8)</td>
<td>9.5 (8-10)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Ureter (Median)</td>
<td>7.5 (0-9)</td>
<td>10 (8-10)</td>
<td>0.001</td>
</tr>
<tr>
<td>How well do you understand the tumor location? (Median)</td>
<td>6 (0-8)</td>
<td>10 (8-10)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Figure 1: Example of Image Segmentation for 3D Model Rendering
Figure 2: Individual Rendered Table 1: Imaging Assessment Questionnaire Responses for 3D Model Rendering Structures; A) Venous; B) Arterial; C) Collecting System; D) Kidney; E) Tumor
INTEGRATION OF ELECTRONIC QUESTIONNAIRES (EQS) AND URODYNAMIC TRACINGS INTO ELECTRONIC MEDICAL RECORDS TO PROVIDE PATIENT–CENTRIC HEALTH CARE IN PELVIC FLOOR DYSFUNCTION

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Introduction: Validated questionnaires are an important part of evaluation and follow up patients with pelvic floor dysfunction. Although used extensively in clinical studies, they have not been widely utilized in mainstream practice. Since the pelvic floor dysfunction is mainly managing patient’s quality of life, eQs are the logical measure of treatment outcomes. With the use of the UC Irvine IT department and in conjunction with Laborie, we implemented eQs and urodynamics data into our electronic medical records (EMR).

Methods: We chose iList® electronic questionnaire application to include 14 validated Urology questionnaires created in https format, and incorporated into an iList website. The text portion of these questionnaires were saved into eLink, a storage interface. This data is then sent to our Quest Media Viewer link via MDM, an HL–7 interface. Following this, the questionnaires are sent to SRM, a medical record depository, via print capture, available for retrieval by the clinician. The urodynamics images and report from Laborie are stored in a long-term storage depository in PDF form. These reports are printed daily via batch script, and then sent to the scanner, where they are scanned into SRM. SRM links directly with Quest, UC Irvine’s electronic health records viewer. eQs were filled by our patients easily on iPads and automatically integrated in the system. Regulatory, quality control, and HIPPA issues were incorporated into the process.

Results: 14 validated questionnaires as well as all urodynamics reports are able to be integrated into the electronic medical record for retrieval by capturing both the text and images portions of the data separately. This data is saved in PDF form in a long-term storage depository, which communicates with Quest via the Quest Media Viewer. Quest ultimately retains either a text version of the questionnaires, along with the media, or image version, in the electronic medical records. With the implementation of iList® in the Urology Clinic, the University of California, Irvine is the first UC campus to have electronic questionnaires in their medical health center.

Conclusion: Implementing iList or similar platform will streamline the way physicians interact with patients, as well as taking one more step in the direction of complete conversion to electronic medical records. This has future implications for advanced patient centric–management and research.
ABSTRACT 17

A SIMPLE MODIFICATION FOR PROSTATE FUSION BIOPSY

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² LOSEV Losante Hospital, Turkey
³ University of Florida, US
⁴ Gazi University Faculty of Medicine, Department of Urology, Turkey

Introduction: Multiparametric MRI and transrectal ultrasound guided targeted prostate fusion biopsy is gaining popularity in prostate cancer diagnosis. Surgeons often have to deal with fecal contents during the biopsy procedure. This novel technique provides improved intra-operative prostate visualization and decreases fecal contamination by using a simple ileostomy adapter.

Methods: From May 2016 to March 2017, 31 patients who had PI-RADS 3 or greater lesions in multiparametric MRI were undergone to prostate fusion biopsy procedures. Biopsy procedures were done through transperineal approach by using transperineal stepper (CIVCO, EX³) and transrectal USG (SmartUS, Telemed). MR images and transrectal USG images were fused with MIM Symphony software (MIM software, Cleveland). In the original technique a preservative filled with 120 ml saline was placed into the rectum; whereas in our modified technique, initially an empty preservative is placed into the rectum and filled with 100 ml ultrasound gel and then fixed to the anus by using a standard ileostomy adapter (Figure 1).

Results: The mean age of patients was 61 (42 -74) and the median PSA level was 5.2 ng/ml (1.15 – 46). The mean prostate volume was 60 cm³ (27-120). We sampled 47 lesions in 31 patients. The mean size of lesions was 10.7 mm (4-25). 49% of lesions were classified as PI-RADS 3, 36% and 15% were classified as PI-RADS 4 and 5, respectively. We obtained a mean of 4.9 cores (2 – 8) biopsy from each lesion. Pathology results revealed that there was prostate adenocarcinoma in 15 lesions out of 47 lesions in 12 patients. Mean anesthesia time was 60 minutes (45-100). None of the patients had fever or urosepsis after the procedure. There was only one patient who had hematuria and urinary retention needed urinary catheterization for 2 days.

Conclusion: MRI and transrectal USG guided targeted fusion biopsy seems to be a feasible and safe method in order to diagnose prostate cancer. Our simple modification provided improved intra-operative prostate visualization and allowed us to perform the procedure in a surgical field without fecal contents.

Figure 1: A preservative is placed into the rectum and then fixed by using a simple ileostomy adapter.
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HIGH VOLUME SKILL ASSESSMENT FOR BASIC LAPAROSCOPIC UROLOGIC SKILLS (BLUS)

Timothy M Kowalewski,1 Bryan Comstock,2 Robert Sweet,3 Cory Schaffhausen,1 Ashleigh Menhadji,4 Timothy Averch,5 Geoffrey Box,6 Timothy Brand,7 Michael Ferrandino,8 Jihad Kaouk,9 Bodo Knudsen,6 Jaime Landman,10 Benjamin R. Lee,11 Bradley F. Schwartz,12 Elspeth McDougall13 and Thomas S. Lendvay14

1 University of Minnesota Mech. Engineering, 2 University of Washington Biostatistics, 3 University of Washington Urology, 4 Boston University School of Medicine, 5 University of Pittsburgh Medical Center 6 Ohio State University Urology 7 Madigan Army Medical Center, USUHS 8 Duke University, Urology 9 Cleveland Clinic, Urology 10 University of California Irvine, Urology 11 University of Arizona, Urology 12 Southern Illinois University, Urology 13 University of British Colombia, Urologic Sciences, 14 University of Washington Urology and Seattle Children’s Hospital

Introduction: In an effort to explore a scalable and rapidly workable methodology for large-scale assessments for Basic Laparoscopic Urologic Skills (BLUS) [PMID22050489, 25911459], a consortium of eight urologic laparoscopic training centers evaluated concurrent validity [PMID26527514] by comparing skills assessment data from crowdsourcing [PMID26421369] with both expert evaluations [PMID26778711] and computerized skill measurement methodologies [PMID20607563, 25108691].

Methods: Surgical performance videos (N=430) of BLUS tasks (Peg Transfer, Cutting, Suturing, and Clip Apply) were subjected to anonymized crowdsourced ratings using the same surveys tools as expert rater panels: Global Objective Assessment of Laparoscopic Skills (GOALS). A representative subset (N=24) received GOALS [PMID15972181] ratings from a faculty panel (N=5). Prerecorded tool motion metrics (tool path length, jerk cost, grasp forces, etc.) were available for each video using the Electronic Data Generation and Evaluation (EDGE) drylab box trainer (Simulab, WA). We evaluated concordance between mean crowd scores to both motion metrics and expert ratings. We used Cronbach’s alpha, Spearman’s rho (>0.8 indicates very strong agreement), and Receiver Operator Curves (ROC) with Area Under Curve (AUC) statistics. We considered correlations statistically significant only at p < 0.01.

Results: Crowworkers provided 16,418 individual reviews of 430 videos in 8.7 days. Spearman’s rho between composite crowd scores and motion metrics ranged from moderately strong to very strong (Peg Transfer 0.84, Cutting 0.72, Suturing, 0.80 and Clip Apply 0.61). ROC curves for each BLUS task (AUC=0.93 Peg Transfer, 0.93 Cutting, 0.88 Suturing, and 0.79 Clip Applying) was consistent with expert faculty skills assessment. GOALS ratings of expert panels and crowds had moderate to strong concordance (0.70 to 0.95) for a range of recordings from novices to experts.

Conclusion: High volume assessment via crowd-sourcing is feasible and concordant with objective BLUS psychomotor tool motion metrics. These surgical skill assessments align with those of expert faculty. Crowdsourcing offers a rapid, scalable approach to the determination of learner proficiency.

Figure: (Left) The EDGE motion capture system used to record tool motion: x,y,z, roll, grasp angle and force and (Right) Representative ROC curve of Crowd Ratings vs EDGE motion metrics cutting (Area Under Curve shown; desired perfect agreement at AUC=1).
AUTOMATED AND DYNAMIC CLASSIFICATION OF BLADDER CANCER USING DEEP LEARNING ON REAL-TIME CONFOCAL LASER ENDOMICROSCOPY IMAGES

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* These authors contributed equally to this work

Introduction: Confocal laser endomicroscopy (CLE) is an approved intraoperative optical imaging system that provides real-time, high resolution imaging of tissue microarchitecture and cellular features similar to histology. CLE of bladder cancer demonstrated diagnostic accuracy of 76% in novice CLE users and 85% in experienced CLE users in the classification of malignant and benign lesions[1]. A significant barrier to clinical adoption of CLE is the skill required for real-time image interpretation. With the availability of large datasets and increasing computational power, machines can now surpass human capability of classifying images due to advancements in machine learning in the form of deep learning algorithms[2]. To decrease the burden on urologists for interpretation, our aim was to create an automated system utilizing deep learning to provide real-time assistance in the diagnosis of CLE images.

Methods: A deep learning algorithm was optimized for image classification and trained using a bladder CLE dataset collected with IRB approval from 81 subjects undergoing cystoscopy/TURBT. The diagnoses of 458 CLE videos were co-registered with clinical pathology reports to establish the ground truth. CLE videos were captured at 8 frames per second using a 2.6 mm diameter CLE probe through a rigid cystoscope. The algorithm received only the CLE images and its corresponding diagnoses as inputs. The dataset was randomly partitioned to 80% training, 10% validation, and 10% testing, resulting in 45 CLE video clips in the test set (consisting of 31% malignant and 69% benign).

Results: Overall accuracy in the prediction of malignant versus benign was 87% (sensitivity 79% and specificity 90%). The algorithm analyzed a total of 170,712 images that were individually captured from the CLE videos. A diagnosis for every individual frame was obtained which was then pooled together to obtain a final diagnosis for each respective video clip. The algorithm was capable of providing frame-by-frame diagnoses with processing time of less than 50 milliseconds per frame. Figure 1 depicts screen captures of streaming CLE video, illustrating snapshots of the dynamic diagnostic feedback.

Conclusion: We developed an automated system for real-time, dynamic diagnosis of CLE images. Our deep learning machine achieved high accuracy, sensitivity and specificity in detecting bladder cancer, with diagnostic accuracy surpassing novice and experienced CLE users from previous studies. Every frame is classified in real-time, allowing for live feedback of the streaming CLE images.

Figure 1: CLE images with real-time, automated diagnoses. Screen captures of CLE videos with accompanying histograms providing frame-by-frame prediction of diagnoses. (A) CLE of benign tissue with 90% prediction that it is not a malignancy for that frame. (B) CLE of bladder cancer with 100% prediction of high grade cancer for that frame. Norm = normal tissue, infl = inflammation, CIS = carcinoma-in-situ, HG = high grade cancer, LG = low grade cancer
ABSTRACTS

ABSTRACT 20

IN-VITRO TESTING OF IUFLOW -- A COMPACT SMARTPHONE BASED UROFLOWMETER

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Introduction: Uroflowmetry is a test that involves normal urination into a flowmeter device, in the clinic, that measures: volume of urine, speed and time of urination. While the clinic is not an ideal environment to obtain representative voids, most clinicians rely on a single office measurements of flow rate, as there is no alternative way of conducting an affordable and precise uroflowmetry test at home. In order to overcome the limitations of the current uroflowmetry devices, a novel uroflowmetry feature was introduced to the iUFlow. The iUFlow is a compact bladder-monitoring device that placed over the toilet bowl and connects to the patient’s smartphone, enabling automated capturing and recording of frequency, volumes as well as uroflowmetry data at home. This is done by an arrangement of sensors under a urine container producing acoustic signals that can be recorded, processed and analyzed via the patient’s mobile device. We examined the uroflowmetry capability of the iUFlow and validated it in laboratory settings using different bladder profiles, patterns and scenarios.

Methods: The repeatability and accuracy of the iUFlow device was examined using a customized, computer-controlled pump connected to a bladder-like container. The pump is configured to simulate 20 different types of bladder emptying flow patterns. Over 180 tests were carried out using purified water. The data produced by the iUFlow was recorded and compared to the known dispense rate of the programmed pump. In parallel, the data from the iUFlow device was compared to the data received from a standard traditional Uroflow device in equivalent settings.

Results: The iUFlow repeatedly reported the correct Volume, Voiding Time and Flow Rates, which were consist with the pump’s preprogrammed dispense volumes and rates. All measurements were within a range of +/- 4% of total volume and Qmax values. The average deviation of the volume measurement was 8.24ml, while in terms of Qmax values the average deviation was 1.9 ml/s. Overall, the iUFlow showed strong agreement and correlations with the standard uroflowmetry. The uroflowmetry charts produced by the iUFlow were repeatedly precise and similar to the chart produced by the computerized system that simulated a bladder-like activity. (See Figure 1)

Conclusion: The iUFlow device demonstrated a strong capability of performing uroflowmetry test in-vitro, with robust repeatability and accuracy. The iUFlow is likely to be a better alternative to the common single office measurement of the standard uroflow device, as it is designed to operate in a home environment. Further studies are undergoing in order to validate the clinical usability and economic benefits of the iUFlow device in the management of patients suffering from Lower Urinary Tract Symptoms.
NOVEL METHOD OF SAFE CATHETER EXCHANGE OVER A GUIDEWIRE AFTER TURP OR PROSTATECTOMY

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Introduction: Foley catheter exchange in the postoperative setting after urologic surgery can be fraught with difficulties, particularly after radical and simple prostatectomy or in patients who experienced undermining of the trigone after transurethral resection of the prostate (TURP). From our experience, blind catheter exchange in the postoperative setting has a higher probability of false passage, often requiring bedside cystoscopy. We developed a simple method of catheter exchange over a guidewire without cystoscopic instrumentation with the use of a Kumpe access catheter. Our goal was to demonstrate the steps for its use at the bedside without the need for flexible cystoscopy or blind foley placement, which can be unsafe and time consuming.

Methods: First, a sterile field is created around the foley catheter with blue towels or a small sterile drape. Then, a 5-french Kumpe access catheter (Cook Medical Inc., Bloomington, IN) is inserted through the indwelling catheter until the Kumpe catheter’s angled tip exits the side-hole of the foley catheter (Figure 1A, 1B). A ‘click’ can be felt when the angled tip exits the foley side-hole. A Sensor or Super Stiff guidewire (0.035” x 145cm Amplatz Super Stiff, Boston Scientific, Marlborough, MA) is advanced through the Kumpe catheter until sufficient redundant wire is coiling inside the bladder (Figure 1C). Using the push-pull technique, the Kumpe catheter and the deflated foley is removed leaving the guidewire in place (Figure 1D). Lastly, a Councill tip or punched foley catheter is safely advanced along the wire into the bladder.

Results: This novel catheter exchange method has been demonstrated successfully and safely in three different patients in the immediate postoperative period: after a TURP in a patient who developed clot retention and required a 3-way catheter to initiate continuous bladder irrigation, after simple retropubic prostatectomy to replace a clotted-off catheter, and after radical prostatectomy to replace a poorly-draining catheter. Each patient tolerated the exchange well without complication.

Conclusion: Safe catheter exchange after certain urologic procedures should be performed over a guidewire. We demonstrated a novel method of safe catheter exchange over a guidewire with a Kumpe access catheter in patients after TURP and prostatectomy.

Figure 1: Demonstration of steps to novel catheter exchange method over a guidewire
ABSTRACT 22

BASIC LAPAROSCOPY TRAINING USING 3D IMAGE TECHNOLOGY
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² FACERES MEDICAL SCHOOL – São José do Rio Preto SP Brazil

Introduction: The Urology resident surgeon develops his technical skills continuously throughout his career. Thus, on its initial training, it requires manual ability development and a learning curve of new operative techniques, acquiring experience to reduce the real surgical risks. 3D video laparoscopy and robotics are the newest medical technologies and should be learned by the youngest generation, especially those in medical residency training worldwide. Despite the existence of robotic virtual simulators that require large financial investments, the absence of less expensive traditional black boxes with the 3D vision system is not available everywhere. Virtual 3D simulators are not available for most students. The new availability of 3D video laparoscopy, and the growing need for a "simplified black laparoscopic 3D view box" was then verified, so that most surgeons in training could gain access to this new technology.

Methods: Therefore, to facilitate the initial training skills in 3D video laparoscopy, this new model was created to visualize the surgical field with 3D virtual reality glasses, using smartphone technology combined with graspers and cardboard box. This device simulates the similar vision found in laparoscopy video camera or robotic surgery in the training procedures. In addition, using a 3D virtual reality glasses imaging system coupled to the black box, we could increase realistic manipulation of objects, tissues, or sutures.

Results: The low-cost device was built without technical difficulty, recreating a short adaptation training field, using 3D virtual reality glasses and tweezers, giving the medical resident in training a realistic simulation close to 3D video images usually seen by expert laparoscopy and robotic surgeons.

Conclusion: The simulator equipment is a low-cost device designed using virtual reality glasses, cell phones and basic laparoscopic materials, and can be easily reproduced today, even in places with a rare budget, and provide a new level of training in laparoscopic surgery and familiarization to robotic surgery images.
HEAT GENERATION DURING HOLMIUM LASER LITHOTRIPSY: EFFECT OF DIFFERENT SETTINGS ON FLUID TEMPERATURE

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Introduction: The holmium laser causes stone fragmentation by a photothermal mechanism. With increasing interest in high frequency laser lithotripsy techniques, and the advent of higher power multi-cavity laser systems, the effect of high-watt laser settings on heat production within the collecting system is relatively unknown. The aim of this study was to investigate the effect of different laser settings on temperature changes during laser lithotripsy in a simulated laboratory model.

Methods: Using a 60-watt holmium laser (VersaPulse PowerSuit, Lumenis, USA) we measured temperature changes when a laser fiber was activated in deionized water kept at room temperature within a glass vial (inner diameter 14 mm/length 60 mm). Activation of laser fiber was performed to mimic non-contact laser lithotripsy scenario (pop-corn effect). Real time temperature was recorded using two thermocouples (Physitemp, NJ) used simultaneously; one was kept 5 mm away from the fiber tip and the second, 7.5 mm away to assess differences in temperature. During each experiment, baseline temperature was recorded for 30 seconds to make sure the water was at a constant temperature, then the laser fired for 60 seconds continuously and then stopped. Temperature recording was continued for an additional 60 seconds. The following settings were explored: 0.2 J X 40 Hz (8W), 0.5 J X 20 Hz (10W), 1.0 J X 10 Hz (10W), 0.5 J X 40 Hz (20W), 1.5 J X 20 Hz (30 W), 1.0 J X 40 Hz (40W), and 1.5 J X 40 Hz (60W). Two laser fiber sizes were tested for each setting - 200 µm and 365 µm (Flexiva, Boston Scientific, MA). The fiber was stripped and cleaved using a ruby scribe prior to each experiment.

Results: Mean baseline temperature was 19.6 °C. Temperature readings from the 5 mm thermocouple at the end of 60 seconds of continuous laser firing using the 200 fiber, and those using the 365 fiber are demonstrated in Figure 1A. Temperature changes were not significantly different between the two distances (5 and 7.5 mm). The temperature increased the most when using settings with power output of more than 10W. The highest recorded temperature change using the 200 fiber was 79.0 °C (Figure 1B).

Conclusion: When activating a laser fiber continuously, we found the temperature of fluid in an in vitro caliceal model rises when increasing the total laser power with temperature increases as much as 59 °C. Further studies are needed to investigate the effect of irrigation and tissue perfusion on caliceal temperature rise, as well as the effect of these changes on ureteroscope longevity during laser lithotripsy.

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AUTOMATED 3D ANATOMIC CHARACTERIZATION OF THE RENAL COLLECTING SYSTEM

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Introduction: Individual variation in renal collecting system anatomy affects kidney stone formation risk, probability of spontaneous stone passage, surgical access, and treatment success. Prior studies correlating features of renal anatomy and stone-free rates after stone surgery have primarily relied on manual measurements from 2D images, limiting their applicability to a 3D system. In addition to aiding patient-specific treatment counseling, better understanding of the 3D collecting system anatomy can aid in novel medical device design. Utilization of powerful image processing techniques to perform such anatomic characterization may also allow for population-based studies on anatomic risk factors for stones. To our knowledge, there are no automated methods for characterization of the 3D renal anatomy. Our goal was to develop an algorithm to automatically segment renal anatomy from CT urograms and identify the central ‘tree’ structure that could then used to characterize the 3D lower pole anatomy.

Methods: In this IRB approved study, CT urograms for hematuria evaluation were identified from our institutional database. Inclusion criteria included normal upper tracts and adequate filling of the collecting system on excretory phase images. We used a learning-based algorithm to automatically segment and crop the kidneys from axial images after which a Gaussian mixture model was employed to segment and reconstruct the renal collecting system. A tree structure indicating the ‘center line’ through the renal pelvis, infundibula, and calyces was subsequently derived. Points on the tree structure representing the proximal ureter, UPJ, and lower pole infundibulum were used to reconstruct a 4 mm thick plane from the 3D volume, which was then used to measure the infundibulopelvic angle (IPA) [1]. An alternate anatomic parameter to characterize the lower pole, the radius of curvature (ROC), was identified by searching for the largest circle bounded by the lower pole tree structure.

Results: Our algorithm was able to successfully segment 8 of 11 renal units identified for use in this preliminary study. IPAs ranged from 14.6-81.5° and the proposed ROC ranged from 9.4-12.3 mm in this cohort of normal subjects.

Conclusion: The described algorithm is technically feasible to aid in automated characterization of the 3D collecting system.

Figure: A) 3D rendering of segmented kidney. B) 3D rendering of segmented collecting system. C) Central tree structure of collecting system. D) Overlays of identified structures. E) Infundibulopelvic angle measurement. F) Radius of curvature measurement.
CONSTRUCTION AND ASSESSMENT OF AN INNOVATIVE VIRTUAL (RADIATION FREE) FLUOROSCOPY PCNL SIMULATOR: AN INDIGENOUS APPROACH TO TRAINING

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Introduction: PCNL has a significant learning curve. Commercial simulators have prohibitive pitfalls. We describe our innovative virtual fluoroscopy PCNL simulator.

Methods: A portable virtual fluoroscopy PCNL simulator was designed (using CAD), patented and constructed. Evaluation using a 3 steps test, GRS performance score and trainee feedback form, was done

Results: Trainees demonstrated statistically significant improvement in GRS scores, total time, fluoroscopic time and attempted needle punctures after training (p<0.001).

Conclusions: Our innovative portable virtual fluoroscopy PCNL simulator uses visible light to reproduce fluoroscopy images. The usual puncture needle with any access technique can be used. It replicates repetitive respiratory movements. The alarm allows trainee evaluation and supervised, repetitive tailored learning in a controlled, low stress environment, It has low initial and maintenance cost and serves as a satisfactory initial puncture practice station. Such virtual fluoroscopy simulators would open up newer avenues in PCNL simulation.

Figure: Trainee using the virtual fluoroscopy simulator.
THE IGEL URETERAL DILATOR: A SINGLE-USE DISSOLVABLE SOLUTION FOR RAPID URETEROSCOPIC ACCESS

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Introduction: The treatment of kidney stones has evolved rapidly in the last ten years. A common hurdle in ureteroscopy is achieving ureteroscopic access to the ureter, which has a natural narrowing at its entrance to the bladder. Commercially available ureteral dilators are expensive and sometimes ineffective, limiting the applicability of ureteroscopy.

Methods: A novel dissolvable ureteral dilator was designed with input from senior Urologic surgeons. Intellectual property disclosures were made and a prior art search completed. Provisional patent protection was filed and the prototyping process was begun. Nine dissolvable compounds were screened and prototypes assembled in the inventors kitchen. Materials were evaluated for dissolution time, melting temperature, caramelization temperature, room temperature hygroscopic properties, previous use in genitourinary tract and constituent sugar previous use in genitourinary tract.

Results: A suitable dissolvable carbohydrate material known commercially as “Isomalt” that was non-hygroscopic, clear and had a history in manufacturing was identified. Using silicone based molding, prototypes were cast. A provisional Patent was filed in Feb 2015 and converted in Feb 2016. Prototypes were hand-cast with commercially available carbohydrate and stored in desiccant containers. Trials of the dilator in an ex-vivo ureteroscopy model demonstrated ease of use and confirmed dissolution time.

Conclusion: A novel, single use, dissolvable ureteral dilator has been invented and the intellectual property protected. A search for a commercial production partner is underway.

Figure: Various Views of the Dilator
THE USE OF LITHOVUE™, A DISPOSABLE FLEXIBLE URETEROSCOPE, REDUCES SCOPE REPROCESSING TIME AND TECHNOLOGIST LABOR

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Introduction: The use of LithoVue™ (Boston Scientific, Marlborough, MA), a single-use digital flexible ureteroscope may disrupt cost paradigms for the diagnosis and treatment of upper urinary tract pathology. Reusable ureteroscopes require sterilization, processing and repair, rendering those scopes unusable for a period after case completion. Single-use ureteroscopes require much less time for recycling or disposal. The aims of this study were to quantify the steps involved in processing reusable flexible ureteroscopes and to identify the time and labor saved when utilizing disposable scopes.

Methods: From July-August 2016, a prospective time-motion study was performed involving the intraoperative use and postoperative processing of reusable (URF-P6, Olympus, Tokyo, Japan) and LithoVue™ single-use flexible ureteroscopes used in treatment of stone pathology at UCSF. Observers timed intraoperative events and all steps involved in scope reprocessing. The subset of steps requiring human personnel was noted. Turnover time between cases was abstracted from anesthesia records.

Results: Fifteen cases utilizing reusable flexible ureteroscopes and ten cases utilizing LithoVue™ were characterized. Seven reusable scopes were followed through reprocessing. Reusable scope cases duration was 52.3 ± 31.2 minutes as compared to 43.2 ± 7.2 minutes for LithoVue™ cases (p=0.37). Mean patient preparation time in the operating room was 34 ± 10 minutes. Room turnover averaged 43 minutes between cases. Reusable scope reprocessing averaged 212 minutes of which 57 minutes required central processing personnel interaction (shaded bars, Figure 1). Processing of LithoVue™ required 4.4 minutes of labor when recycled and 0.33 minutes when disposed.

Conclusion: Reprocessing of reusable scopes at UCSF requires 3.5 hours, of which one hour is human labor-dependent. Accounting for room turnover and patient preparation time, a reusable scope utilized during the first case of the day would not be ready for use until midway through the third case. Use of disposable flexible ureteroscopes nearly eliminates this time and labor requirement and may facilitate an increased number of cases performed per day with fewer ureteroscope resources invested.

Figure 1: Timing of scope processing steps and intraoperative case flow for reusable flexible ureteroscopes
THE ANATOMICAL REGION SELECTED FOCAL THERAPY WITH TRANSRECTAL HIGH-INTENSITY FOCUSED ULTRASOUND FOR LOCALIZED PROSTATE CANCER BASED ON THE SPATIAL LOCATION OF SIGNIFICANT CANCER ON MULTI-PARAMETRIC MRI

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Introduction: To evaluate the efficacy and invasiveness of the anatomical region selected focal therapy with trans-rectal high-intensity focused ultrasound (HIFU) for localized prostate cancer based on the spatial location of significant cancer on multi-parametric magnetic resonance imaging (MRI).

Methods: The patients with low- and intermediate-risk group who were diagnosed the spatial localization of the prostate significant cancer in the prostate were recruited prospectively. The spatial localization of the significant cancer was diagnosed with MRI-transrectal ultrasound (TRUS) fusion image-guided trans-perineal prostate biopsy using the BioJet® system (D&K Technologies GmbH, Barum, Germany). The focal therapy was performed to the significant cancer detected regions with trans-rectal HIFU using Sonablate® 500 (SonaCare medical, Indianapolis, IN, USA). To evaluate the efficacy of the treatment, serum prostate specific antigen (PSA) kinetics and three-dimentional (3D) reconstructed multi-parametric MRI were analyzed (Figure). To evaluate the invasiveness, questionnaires (IPSS, QOL, OABSS, IIEF-5, SF-36 Japanese version 2) and uroflowmetry were performed. Adverse event was evaluated with Common Terminology Criteria for Adverse Events (CTCAE) ver.4.0.

Results: Fifteen patients with median age at 64 years (48-79) and median PSA at 7.2 ng/ml (4.67-15.99) were treated. All men (15 of 15 patients) had pad-free/leak-free continence at 1 and 3 months after the treatment. The proportion of men with erections sufficient for penetration was not decreased from 73% (11 of 15 patients) to 73%. Catheterization was within 24 hours after the treatment in all patients. The median PSA of the patients significantly dropped from 7.2 ng/ml to 1.76 ng/ml (p=0.001) at 3 months after the treatment. The contrast-enhanced MRI and dynamic MRI showed the disappearance of blood flow in all targeted regions of the prostate with 3D evaluation of the MRI. There was no significant difference between before and after the treatment at 3 months in urinary symptoms (IPSS change, p=0.3, QOL change p=0.7, OABSS change, p=0.6, max flow rate change, p=0.6, residual urine change, p=0.1), erectile function (IIEF-5 change, p=0.6), and QOL (SF-36 change in all domains). Urinary tract infection with CTCAE Grade 2 was found in 1 patient (6.7%).

Conclusion: The anatomical region selected focal therapy with HIFU would have potential to provide promising results with accurate treatment for the significant cancer and low morbidity.
THREE-DIMENSIONAL COMPARISON OF PERIRENAL FAT VOLUME IN PATIENTS WITH UNILATERAL NEPHROLITHIASIS

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Introduction: Risk factors for kidney stone formation, such as obesity and insulin resistance, are also implicated in the redistribution of visceral adipose tissue. It is currently unknown whether the perirenal fat, and thus the perirenal fat volume (PFV), of a stone-bearing kidney is metabolically distinct from a non-stone-bearing kidney. Therefore, we conducted a study utilizing Vitrea® Advanced Visualization Software (Vital Images Inc., Minnetonka, MN) for the volumetric evaluation of PFV in patients with unilateral nephrolithiasis.

Methods: We performed a retrospective review of 97 patients who underwent percutaneous nephrolithotomy (PCNL) between March 2005 and March 2016. We obtained patient characteristics including demographics, body mass index (BMI), and history of diabetes mellitus (DM). Furthermore, we grouped patients by predominant stone composition (i.e. greater than 50% composition), and recorded stone size, location, and stone composition fraction (calcium oxalate (CO), calcium phosphate (CP), uric acid (UA), and ammonium-based (NH) calculi). Exclusion criteria included a history of bilateral nephrolithiasis, complex cystic or enhancing mass on computed tomography imaging, renal cell carcinoma, open renal surgery, extracorporeal shock wave lithotripsy, or previous PCNL. Radiology residents at our institution, supervised by senior faculty, performed the bilateral PFV measurements. For statistical analysis of PFV, paired-samples t-test was used.

Results: Forty patients met inclusion criteria. BMI was stratified per predominant stone composition; the CO group BMI was significantly lower (mean 27.8) compared to the CP (mean 34.2) and UA (mean 34.2) groups (p=0.0242). A total of 15 patients had DM: 37% in the CO group, 22% in the CP group, and 60% in the UA group. The mean stone size was 2.42 cm on axial CT and 3.0 cm on coronal CT. Analysis included 15 renal pelvic stones, 8 calyceal stones, and 17 complete staghorn stones. The mean PFV of the stone-bearing kidneys (397.3 cc) was significantly greater compared to the unaffected side (323.0 cc) (p=0.0034). PFV of the stone-bearing kidney was greater irrespective of composition group assignment, however the CO-dominant group reached significance (p=0.0032). Subgroup analysis showed a greater PFV surrounding stone-bearing kidney regardless of gender (p=0.0323 and p=0.0223, male & female respectively) or a history of DM (p=0.1211).

Conclusion: The PFV of calcium oxalate stone-bearing kidneys is significantly greater than non-stone bearing kidneys. Additionally, the BMI of patients with calcium oxalate stones is significantly lower than in patients with calcium phosphate or uric acid stones.

Figure 1: Vitrea® perirenal fat volume measurement
ROBOTIC RADICAL PERINEAL CYSTECTOMY AND EXTENDED PELVIC LYMPHADENECTOMY: INITIAL INVESTIGATION USING A PURPOSE-BUILT SINGLE-PORT ROBOTIC SYSTEM

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Introduction: We sought to assess the feasibility of perineal radical cystoprostatectomy using the latest generation purpose-built single-port robotic surgical system.

Methods: In two male cadavers, the da Vinci SP1098 Surgical System was used to perform radical cystoprostatectomy and bilateral extended pelvic lymphadenectomy. New features in this model include enhanced high-definition three-dimensional optics, improved instrument maneuverability, and a real-time instrument tracking and guidance system. The surgery was accomplished through a 3-cm perineal incision via a novel robotic single-port system, which accommodates three double-jointed articulating robotic instruments, an articulating camera, and an accessory laparoscopic instrument. The primary outcomes were technical feasibility, intraoperative complications, and total robotic operative time.

Results: The cases were completed successfully without conversion. There were no accidental punctures or lacerations. The robotic operative times were 197 and 202 minutes.

Conclusion: In this preclinical model, robotic radical perineal cystoprostatectomy and extended pelvic lymphadenectomy was feasible using the SP1098 robotic platform. Further investigation is needed to assess the feasibility of urinary diversion using this novel approach and new technology.
ABSTRACTS

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IN VIVO EVALUATION IN A PORCINE MODEL OF HYDRUSTENT® - BIODEGRADABLE URETERAL STENT

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Introduction: Ureteral stents are related with severe complications in urologic practice, such as infection, pain, irritation and encrustation [1]. Furthermore, they require a second procedure for removal. Additionally, ureteral stents are often forgotten with additional complications to the patient [2]. Biodegradable ureteral stents are one of the most attractive designs with the potential to overcome the complications associated with stenting [2,3].

Methods: We have developed a biodegradable ureteral stent based on natural origin polymers (HydrUSTent®) and in this study, we evaluated its performance in vivo. A total of ten female Yorkshire pigs were used in this study. Six biodegradable ureteral 6-Fr stents and 3 commercial 6-Fr stents were unilaterally inserted by cystoscopy in 2 groups of animals. Intravenous pyelography, blood and urine tests were carried out before the procedure (0 day), and at day 1, 5, 7 and 10. During the in vivo degradation, the mechanical characteristics of stents were tested in tensile mode and compared with the in vitro degradation performed in artificial urine solution. On day 10 all pigs were euthanized. Histological analysis was performed to verify the variation in ureters between the two different groups.

Results: All biodegradable ureteral stents had completely degraded by day 10, without the presence of any fragments in the ureter and bladder. From day 1 to day 10, hydronephrosis was significantly less with the biodegradable ureteral stents than with the control. Preoperative and postoperative blood and urine results were similar in all samples from the animals implanted with the biodegradable ureteral stent. In the case of commercial stent group a significant difference was observed in values of serum hemoglobin before and after stent placement. The biodegradable stents recovered at day 5 and day 7, after sacrificing the animals demonstrated to have mechanical properties similar to the conventional commercial stents and showed that stents degrade by surface erosion with a similar degradation profile to which was observed in vitro. Histological analysis of the ureters showed that the stent-related tissue reaction of the two different stents was different and lower inflammation was observed in the case of biodegradable ureteral stent (Figure 1).

Conclusion: Biodegradable ureteral stents made from natural origin polymers are biocompatible, with suitable mechanical properties and a homogenous degradation. The results obtained demonstrate that this biodegradable stent has the capacity to provide a temporary urine drainage as good as the non-degradable commercial stents with significantly less inflammation and hydronephrosis.
ABSTRACTS

THE EVALUATION OF THE PELVIC ORGANS AND PELVIS BEFORE AND AFTER THE PELVIC ORGAN PROLAPSE SURGERY, USING THE 3D MODEL RECONSTRUCTED WITH COMPUTED TOMOGRAPHY

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Introduction: We evaluated the three-dimensional (3D) relationship of the pelvic organs and pelvis before and after the pelvic organ prolapse surgery, using the 3D model reconstructed with computed tomography (CT).

Methods: From 2015 to 2017, CT examinations (Aquilion ONE, TOSHIBA, Tokyo, Japan) performed in the patients who were received pelvic organ prolapse surgery. The patients were performed CT scanning in the supine position without abdominal pressure. 3D model of the pelvis and pelvic organs were reconstructed with the 1mm slice thickness of CT images using Ziostation 2 Version 2 (Ziosoft, Tokyo, Japan). Posterior urethra-vesical angles (PUVA), ischial spine angle, and blood vessels in pelvis were measured in the 3D model.

Results: Eight patients were enrolled in the present study. Median age and BMI was 71 years-old (range, 65-80) and 25 (range, 20-29). Patients’ number of POP-Q stage III and IV were 3 and 5. Patients’ number of the surgery type of TVM-A, TVM-AP, and TVM-C were 3, 4, and 1, respectively. In preoperative results, median operative time and blood loss was 150 minutes (range, 124-223) and 72 ml (range, 26-274). Although median pre- and post-posterior urethra-vesical angles (PUVA) were not significantly changed (118 degrees vs. 124 degrees, p=0.9), large expansion was found in the case with post-operative de-novo stress urinary incontinence (from 112 degrees to 138 degrees). Pre-operative measurement of ischial spine angle (median 116, range, 91-129) was useful to predict the palpability of the ischial spine during the operation. Further, the pre-operative 3D information of the relationship between the ischial spine angle pelvic arteries was useful to avoid the arterial injury during operation.

Conclusion: The 3D evaluation of the pelvic organs and pelvis before and after the pelvic organ prolapse surgery, using the 3D model reconstructed with CT has potential to recognize the pelvic anatomy and perform safety operation.

3D information of the relationship between the ischial spine and pelvic arteries
RAPID ABLATION OF LARGE URINARY STONES USING A NOVEL, HIGH PEAK POWER, THULIUM FIBER LASER

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Introduction: Our laboratory is studying the Thulium fiber laser (TFL) as a potential alternative to the clinical gold standard Holmium:YAG laser for lithotripsy. The TFL wavelength of 1940 nm is 4-5 times more strongly absorbed by water in tissue than the Holmium wavelength of 2120 nm, enabling TFL lithotripsy at lower energy per pulse. However, previously reported studies were limited by use of a TFL with peak power of only 70 W (35 mJ / 500 $\mu$s). This required operation in “dusting” mode with energy of only 35 mJ, compensated by high pulse rates of 300 Hz. In this study, a new TFL, capable of operation at up to 500 W peak power (7x higher than old TFL), up to 50 W average power, and pulse rates up to 2000 Hz, was tested. We studied the efficacy of the laser for ablation of large urinary stones using three different techniques: dusting, fragmentation, and mixed mode (fragmentation then dusting).

Methods: A compact, air-cooled, high-power, Thulium fiber laser (IPG Medical, Marlborough, MA) with 1940 nm wavelength was used (Figure 1A). A total of 23 uric acid stones (1.2 - 2.5 cm, 1.3 - 2.7 g) were separated into three groups with similar average mass (1.9 ± 0.5 g, 1.9 ± 0.5 g, and 1.9 ± 0.4 g). Each group was exposed to average power of 10 W and pulse duration of 500 $\mu$s, using a 270-µm-core fiber. In Group 1 (Dusting), TFL was operated at 33 mJ and 300 Hz (n=9). In Group 2 (Fragmentation), TFL was operated at 200 mJ and 50 Hz (n=7). In Group 3 (Mixed Mode), the stone was fragmented at 200 mJ/50 Hz, followed by dusting at 33 mJ/300 Hz (n=7). All experiments were performed with the fiber tip held manually in contact with the stone resting on a 2-mm-mesh sieve and immersed in a bath with saline flow. Ablation rates were determined by dividing initial stone mass by total treatment time.

Results: Procedure times measured 918 ± 312 s, 855 ± 245 s, and 436 ± 118 s, and ablation rates were calculated to be 2.3 ± 0.8 mg/s, 2.3 ± 0.2 mg/s, and 4.4 ± 0.8 mg/s for Groups 1, 2, and 3, respectively (Figure 1B). The combination of fragmentation and dusting provided two times faster stone ablation.

Conclusion: A novel, high peak power, TFL rapidly ablated large uric acid stones in fragmentation, dusting, and combined modes. Preliminary results with this new TFL provide higher ablation rates than reported in earlier TFL studies. Future studies will explore a wider range of stone types and laser parameters to determine if the TFL is a viable alternative to Holmium laser for treatment of large stones.
TRUS-ROBOT GUIDED PROSTATE BIOPSY
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Introduction: A freehand TRUS-guided prostate biopsy has significant limitations with spatially clustered and poorly targeted biopsy cores [PMCID:23088974]. Robotic assistance has the potential to help a urologist improve the geometric distribution of the cores and clinical outcomes. We report our preliminary results of a safety and feasibility study of robot-guided biopsy in 3 patients.

Methods: A novel robotic biopsy device, the TRUS Robot with a 4 degree of freedom, was used to manipulate the TRUS probe during prostate biopsy [PMCID:24795525]. The robot controller was built on a PC platform running Windows 10 (Microsoft Corp.) with image acquisition (Orion HD, Matrox Inc.) and motion control cards (DSP4000, PMDI). The software was built using Visual Studio 2015 C++ (Microsoft Corp.) with VTK, OpenCV public domain libraries. The software performed the ultrasound image acquisition, image processing and navigation, biopsy planning, and controlled the motion of the robot based on the images.

The robot is supported by an arm attached to the procedure table. A standard end-fire TRUS probe (Hitachi-Aloka EUP-V53W) with a needle-guide was attached to the robot. With the patient in a lateral decubitus position, after local anesthesia, the TRUS probe together with the robot was manually placed and positioned to image the prostate. Then, the support arm was locked in place to hold the position (Figure 1). An image scan was performed first. The robot automatically rotated the probe and acquired 2D ultrasound images and their respective positions. The software reconstructed the 3D image of the prostate and surrounding tissues [PMCID:23358940]. The urologist defined the 12-core biopsy plan based on the images. Then, the robot calculated the best approach to each target while optimizing the sequence of the cores. The Max-Core 18Ga x 20cm needle (Bard Biopsy Systems) was used to obtain biopsy cores. The software used the specific needle information to calculate the depth of needle insertion, so that the planned core would be centered on the sample magazine after firing the needle.

The robot automatically oriented the needle-guide on each target for biopsy. The urologist simply inserted the needle through the needle-guide up to the depth that is marked on the real-time ultrasound image, and fired the biopsy device. For the purpose of the study, images of the fired biopsy needle were acquired before retracting the needle, so that their position could be documented and targeting errors could be calculated.

The images were analyzed after the procedure. Targeting errors were measured as the vector distance between the target point and the center of the biopsy magazine slot on the needle from the images. Targeting accuracy and precision were calculated as the average and standard deviation of the errors.

Results: After IRB approval and informed consent were obtained, 3 men underwent the robotic biopsy procedure without complications. The robot allowed a steady, automatic image acquisition and manipulation of the probe. Approximately 250 images were acquired for each patient with a rotary scan, resulting in high resolution 3D images. The entire prostate can be imaged with a rotary scan. Reconstructed images allowed the 12-core biopsy planning. The robot and software allowed a smooth and minimal movement between biopsy cores. Targeting accuracy was 0.49mm and precision was 0.22mm. The average procedure time was 13.6 min.

Conclusion: TRUS Robot-guided prostate biopsy is safe and feasible. It helps the urologist define the biopsy plan, provides a mechanism to accurately sample the gland accordingly, and provides quality control on the actual distribution of the cores. Geometrically accurate biopsy core sampling may improve clinical outcomes.

Acknowledgement: This project was supported by the Patrick C. Walsh Prostate Cancer Research Fund, Johns Hopkins. The ultrasound equipment used in the study was provided by Hitachi Healthcare.

Figure 1: Robot assisted biopsy
Figure 2: Extended sextant biopsy plan
ROBOTIC FLEXIBLE URETEROSCOPY WITH ROBOFLEX AVICENNA – ADITIONNAL ADVANTAGES

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Introduction: As recently reported the new robot for flexible ureteroscopy “Avicenna Roboflex” produced by Elmed-Turkey is used now in four Urologic Departments (Ankara, Paris, Heilbronn and Bucharest). In this paper we would like to show an additional advantage of this new device, concerning a more efficient control of the irrigation fluids during the endoscopic procedures.

Material and methods: Avicenna Roboflex consists of a console and manipulator. The hand piece of the scope is locked to the robotic arm. The surgeon can control from the console, two joy-sticks to manipulate the rotation, deflection and in and out movement of the endoscope. Also, he cans rotate robotically at 440 degrees. This minimizes the torsion risk of the endoscope. A very important aspect is that the integrated water pump can be also adjusted remotely. By this way, it is possible to treat the stone with minimal flow rate and to provide low pressure lithotripsy.

Results: Robotic flexible ureteroscopy was utilized in the treatment of about 100 renal stones in 65 patients between June 2015 and February 2016, for an average dimension of the stones of 2.1 cm (range 1.1-3.2 cm), with a mean operatory time of about 38 minutes (range 30-55 min).In all these procedures, the efficiency of controlling the irrigation fluids during the endoscopic procedures provided an increased control in the operatory field, thus resulting and a low complication rate of only 12.2\% (of which 9.2\% were Clavien I and II and 3.1\% was Clavien III) and also it provided an increased comfort for the operator.

Conclusions: Avicenna Roboflex is a new and suitable platform for the flexible ureteroscopy, with few considerable additional advantages in comparison with classic flexible ureteroscopy.
ABSTRACT 36

FLUID DYNAMIC ANALYSIS OF MANUAL PRESSURE INFUSOR IRRIGATION

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Department of Urology, University of California, Irvine, Orange, CA

**Introduction:** The manual hand-pump infusor device is a commonly used method of generating irrigation for endoscopic urologic procedures. The three-liter hand-pump infusor device consists of a manometer connected to the hand-pump-inflated compression balloon to assess the pressure imposed on the bag of irrigation fluid. To the best of our knowledge, the flow rate and accuracy of the compression bag’s manometer reading has not been investigated. Herein, we describe an in vitro fluid dynamic study utilizing a hand-pump infusor device attached to a flexible ureteroscope with and without various sized devices placed through the working port.

**Methods:** The Flex-X2 ureteroscope (Karl Storz Inc., Germany) was attached to a 3-liter bag of saline using standard irrigation tubing. The saline was placed into a hand-pump infusor (Ethox Infu-surg®, SunMed LLC., MI) and suspended from an intravenous pole. At the distal end of the irrigation tubing, a 3-way valve was attached with one valve to the irrigant, one valve to a digital manometer (DM8252, General Tools and Instruments LLC., Secaucus, NJ) and the third valve connected to the ureteroscope. Two trials were completed; flow and pressure measurements were performed at three pressure infusor settings (250, 200, and 150 mmHg) as indicated by the hand-pump infusor’s manometer. Once the infusor was set at the desired pressure, it was not reinflated over the course of the trial. Data were collected at 0, 1, 2, 5, 10, and 15 minutes; the working channel was studied when it was open and when it was occupied with one of the following: a 200 nm holmium laser fiber (Cook Medical Inc., Bloomington, IN), a 1.7F NGage nitinol stone basket (Cook Medical Inc., Bloomington, IN), and a 0.035 in. (2.67F) guidewire (Amplatz Super Stiff, Boston Scientific Co., Malborough, MA) occupying the ureteroscope. The digital manometer was tared before measuring the inflow pressure at each time point.

**Results:** The measured pressure of irrigation at each infusor setting is shown in Table 1. The infusor’s manometer underestimated the pressure delivered to the ureteroscope by 40-65 mmHg at each setting. Figure 1 depicts flow rates over the 15-minute trial. Using the formula for exponential decay in Figure 2, $V_e = V_o e^{-rt}$, where $V_e = $ volume expected, $V_o = $ volume observed, $r = $ rate constant for 250 mmHg, and $t = $ time the observed depletion of irrigant volume for an open-channel was not significantly different than the expected decay ($p = 0.678$).

**Conclusion:** Large discrepancies exist between the pressure displayed on the hand-pump infusor’s manometer and the measured pressure of irrigation at the point of inflow to the ureteroscope. With an open channel, irrigation volume falls exponentially and, thus an assistant is needed to frequently monitor and maintain the desired infusor pressure.

<table>
<thead>
<tr>
<th>Table 1: Mean measured irrigant flow pressure (mmHg) at 5-minute intervals.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5 min</td>
</tr>
<tr>
<td>10 min</td>
</tr>
<tr>
<td>15 min</td>
</tr>
</tbody>
</table>

**Fig. 1:** Flow rate at each infusion pressure setting for each experimental condition.

**Fig. 2:** Observed vs. expected decay of irrigant volume.
ABSTRACT 37

ROBOT-ASSISTED PERCUTANEOUS NEPHROLITHOTOMY – USING TECHNOLOGY FOR EASIER PERCUTANEOUS ACCESS

Mon Mon Oo¹, Gandhi Himesh¹, Chong Kian Tai¹, Jason Ng², Alan Goh², Tan Yung Khan¹

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²NDR Medical Technology Pte. Ltd. Singapore.

Introduction: Robot-guided PCNL (e.g. PAKY and MINI-RCM) has been developed for reducing complications associated with percutaneous access. However, their utility is still limited due to complex assembly and cost. To reduce the time in obtaining access, we developed a Smart Robot GUI (Graphic User Interface) system for robotic PCNL.

Methods: Prototype robot has an articulated arm with motion feedback control. The GUI software is able to register and integrate images from fluoroscopic C-arm on table. GUI is able to detect the needle location in real-time and can respond to changes of the needle trajectory with respect to the X-ray plane in multi-planar direction. The robot prototype is developed by first testing on a gelatin model to optimize accuracy in targeting the desire calyx. We then moved onto trials in a live pig model. Using this robotic system to aid us, we attempted percutaneous punctures on a live pig model and compared the results with free-hand technique. All punctures were performed by a fellowship trained surgeon. The robotic system was set up as shown in Figure 1. For more accurate targeting, we held respiration for up to 1 minute during robot-assisted punctures. Data on fluoroscopic time, radiation dose, puncture time and total time for procedure were recorded for each of the 5 attempts for robot-assisted and free-hand punctures.

Results: Initial results for live animal trials are as shown in Table 1. There is less radiation dose and time required during puncture for robotic assistance. Although total duration of procedure and puncture time involved setting up the robotic equipment onto the animal and waiting for the system to complete the alignment, this did not result in significant increased time to attaining a successful puncture as compared to free-hand technique.

The automated bull’s-eye alignment by the software and the stabilization of needle trajectory during puncture enabled the surgeon to attain access more confidently and accurately.

Conclusion: Smart Robotic system (GUI) helps surgeons feel more confident, shorten the learning curve, increase the accuracy, potentially reduce the complications and thereby may enable more surgeons to adopt this procedure.

<table>
<thead>
<tr>
<th>Puncture Type</th>
<th>Robot-assisted, mean (±SD)</th>
<th>Free-hand, mean (±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fluoroscopic time (secs)</td>
<td>26.8 (±5.2)</td>
<td>32.6 (±22.5)</td>
</tr>
<tr>
<td>Puncture fluoroscopic time (secs)</td>
<td>13.2 (±1.5)</td>
<td>22 (±17.2)</td>
</tr>
<tr>
<td>Total radiation dose (mGy)</td>
<td>15.2 (±12.4)</td>
<td>15.4 (±6.5)</td>
</tr>
<tr>
<td>Puncture radiation dose (mGy)</td>
<td>8.2 (±13.7)</td>
<td>11.2 (±7.1)</td>
</tr>
<tr>
<td>Total time (mins)</td>
<td>3.15 (±0.26)</td>
<td>3.01 (±0.42)</td>
</tr>
<tr>
<td>Puncture Time (mins)</td>
<td>2.00 (±0.11)</td>
<td>1.43 (±0.34)</td>
</tr>
<tr>
<td>Alignment time (mins)</td>
<td>1.20 (±0.11)</td>
<td>NA</td>
</tr>
</tbody>
</table>

Figure 1: The porcine trial using the smart robotics system (SRS) (Left), with respective fluoroscopic image on the smart robotics system (SRS), needle and kidney (right).
HAPTIC TECHNOLOGY AS A PLATFORM FOR EMULATION OF PERCUTANEOUS NEPHROLITHOTOMY IN A NOVEL DEVICE (HAPTO-PERC) ENHANCES PATIENT-SPECIFIC TRAINING AND TACTILE FEEDBACK TO UROLOGISTS WITH SCARCE EXPERIENCE

Juan Ramón Torres-Anguiano¹, Cristian Luciano¹, Andrea Faso, Zaki Almallah¹, Craig Niederberger², Ervin Kocjancic².

¹Department of Urology, University of Illinois at Chicago, Chicago, IL.

**Introduction:** Percutaneous nephrolithotomy (PCNL) is a surgical procedure for kidney stone extraction requiring the development of complex skills. Most of the experience obtained is situational, depending on the cases available for the trainees [PMC3928925]. Current PCNL training models require pre-made puncture structures, or otherwise animals and thus, exposure to fluoroscopy, becoming costly, unsafe and inaccurate to the wide variety of difficult patient situations [PMID: 23357932]. The hapto-perc is an ex-vivo 3D device for urological training in PCNL without fluoroscopy usage, providing accurate tactile feedback and patient targeted simulations. The aim of this work is to present a novel haptic emulator for PCNL exploring the capabilities of its use among urological surgeons and trainees.

**Methods:** Our model consists of a patient-specific dataset of images, assigned with haptic properties engaged to an augmented reality surgical simulator that includes a controller linked to a tracking system. The images are obtained from the DICOM set of files, of a previously obtained abdominal CT scan, which are then put into digital segmentation, thus being divided into major structures according to the tactile properties expected based on the Hounsfield units. The skin, abdominal and lumbar muscles, ribs, kidneys, and kidney stones are mapped into voxels and assigned different stiffness coefficients (Figure 1). The computer-generated virtual fluoroscopy is obtained by displaying a volume graphics rendering of the CT dataset to emulate the appearance of real fluoroscopy, the images are dynamically updated to emulate the C-arm movements. The trainee is able to obtain tactile feedback along all the puncture process, including reaching the desired calix and the desired kidney stone.

**Results:** Haptic emulation of PCNL has been successfully achieved by this model in order to provide an accurate preoperative planning for complex stone cases undergoing this procedure. Our simulator might play a preoperative role preparing the surgeon for unadvised situations, such as complex calix orientation measuring the use of radiation exposure.

**Conclusion:** Hapto-Perc is a novel training option, serving as an accurate and real case simulation platform for PCNL training, and preoperative preparation for complex kidney stone accesses. Further validation studies among trainees and urologic surgeons are encouraged in order to explore its possible capabilities.
ABSTRACT 39

TRANSPERINEAL ELECTROMAGNETICALLY-TRACKED MR/US FUSION-GUIDED PROSTATE BIOPSY IS SAFE AND EFFICACIOUS FOR THE DETECTION OF CLINICALLY SIGNIFICANT PROSTATE CANCER

Jared S. Winoker, Harry Anastos, Pratik A. Shukla, Kyle A. Blum, Cynthia J. Knauer, Ashutosh K. Tewari, Sara C. Lewis, Bachir Taouli, Ardeshir R. Rastinehad

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2 Department of Radiology, The Icahn School of Medicine at Mount Sinai, New York, NY

Introduction: For over 30 years, transrectal ultrasound guided prostate biopsy (TRUS-Bx) has been the standard diagnostic modality for prostate cancer (PCa) in at risk men. The advent of multiparametric magnetic resonance imaging (mpMRI) of the prostate and fusion biopsy platforms have significantly improved the diagnostic accuracy of the TRUS-Bx. However, in the face of rising rates of multi-drug resistant bacteria and potential risk of infection with TRUS-Bx, there has been a renascence of the transperineal biopsy. Herein, we report our experience with the largest known series of electromagnetically (EM) tracked transperineal MR/US fusion guided prostate biopsy (tpFBx).

Methods: Between July 2015 and September 2016, 52 men underwent tpFBx of suspicious lesions noted on mpMRI (n=48 3T, n=4 1.5T) of the prostate without endorectal coil. A standard 12-core modified Barzell template mapping biopsy was performed at the same time. The procedure was performed under sedation and all patients received 160 mg Gentamicin IV 30 minutes prior. Patient demographics, MR imaging characteristics, PI-RADS v2 scores, histopathologic data, and adverse events were recorded. All patients were followed for 30 days following biopsy.

Results: Of the 52 men biopsied, 25.0% (n=13) had an abnormal DRE, 92.3% (n=48) had an elevated PSA, 57.7% (n=30/52) had been previously biopsied, and 21.1% (n=11) were on active surveillance (AS). Median age was 67.8 years; median PSA was 7.3 ng/mL. Overall cancer detection rate (CDR) was 80.8% (42/52) and 69.2% (36/52) of men had clinically significant (CS) disease. 72.7% (8/11) men initially on AS were found to have CS PCa. At 30 days post-biopsy, just 1 of 52 patients had developed a biopsy-related fever with negative cultures and no signs of sepsis.

Conclusion: In the largest series to date, transperineal fusion biopsy was highly efficacious with a CDR comparable to other fusion biopsy platforms, as reported in the literature. There were no cases of sepsis following biopsy, demonstrating the relative safety of the procedure. While larger numbers are needed to further validate the findings, our series presents tpFBx as an acceptable alternative for patients with a suspicious lesion on mpMRI undergoing prostate biopsy and may be particularly beneficial in men undergoing repeat biopsies for restaging, AS, or focal therapy.

Acknowledgments: Invivo, Gainesville, FL
ABSTRACT 40

DOES MULTI-PARAMETRIC MRI PREDICT POSITIVE SURGICAL MARGINS AFTER ROBOT-ASSISTED RADICAL PROSTATECTOMY? A RETROSPECTIVE COHORT STUDY

Amr Mahran¹,², Christina Buzzy², Rayan Abboud¹, Kyle Scarberry¹, John Francis¹, Vikas Gulani²,³, Lee Ponsky¹,²

¹Urology Institute, University Hospitals Cleveland Medical Center,
²Case Western Reserve University School of Medicine,
³Department of Radiology, University Hospitals Cleveland Medical Center, Cleveland, Ohio 44106

Introduction: There is a strong correlation between positive surgical margins (PSM) and progression to biochemical failure after radical prostatectomy (PMID18838211). Our objective is to identify predictors of PSM in patients undergoing multi-parametric MRI (mpMRI) of the prostate and robot-assisted laparoscopic radical prostatectomy (RALP).

Methods: Under an IRB-approved retrospective study, we identified 70 treatment-naïve patients who underwent 3T mpMRI of the prostate within 10 months prior to RALP (median of 2 months) for clinically localized prostate cancer between January 2014 and December 2016. SPSS 24 was used in the statistical analysis.

Results: Thirty-one out of 70 cases (44.3%) had positive surgical margins (12 had a tumor staging of PT3a, 12 had PT3b, and 7 had PT2c). 21 out of 31 had extraprostatic extension on the final pathology report. On univariate regression analysis, we found that pre-operative PSA > 10 ng/ml (p= 0.002) and PSA density > 0.3 (p=0.031) were independent predictors. The independent predictors identified on mpMRI were lesion with a PI-RADS 5 score (p= 0.045), extracapsular extension (ECE) (p= 0.015), and transitional zone (TZ) lesion with a PI-RADS 4 or 5 score (p= 0.008). None of the initial biopsy variables including the Gleason score showed statistically significant prediction for PSM. Multivariate analysis revealed that ECE on MRI (p= 0.027) and PSA > 10 ng/ml (p= 0.004) were independent predictors for PSM after RALP (Table 1).

Conclusion: Patients with ECE identified on mpMRI have a high risk of PSM after RALP. Surgeons should take this into consideration when planning to treat these patients.

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### Table 1: Demographics, clinical characteristics and multivariate logistic regression models for predictors of PSM after RALP

<table>
<thead>
<tr>
<th>Variable</th>
<th>Negative margin</th>
<th>Positive margin</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>61 (47-72)*</td>
<td>63 (49-77)*</td>
<td>0.892¹</td>
</tr>
<tr>
<td>Race (African American)</td>
<td>13/38 (34.2%)</td>
<td>10/30 (33.3%)</td>
<td>0.573</td>
</tr>
<tr>
<td>Race (White)</td>
<td>25/38 (65.8%)</td>
<td>20/30 (66.7%)</td>
<td></td>
</tr>
<tr>
<td>Pre-RP PSA</td>
<td>21.1 (20.1-45.7)*</td>
<td>29.3 (20.5-40.7)*</td>
<td>0.718¹</td>
</tr>
<tr>
<td>Pre-RP PSA</td>
<td>6.6 (2.03-22.17)*</td>
<td>10.06 (2.3-88.28)</td>
<td>0.006³</td>
</tr>
<tr>
<td>Average PI-RADS Score</td>
<td>4 (2-5)*</td>
<td>5 (2-5)*</td>
<td>0.052¹</td>
</tr>
<tr>
<td>Bx Gleason Score</td>
<td>7 &quot;4+3&quot; (6-9)*</td>
<td>7 &quot;4+3&quot; (6-9)*</td>
<td>0.623¹</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P value</th>
<th>OR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-RP PSA &gt; 10</td>
<td>7.967 (1.916-17.968)</td>
<td>0.002</td>
<td>6.241 (1.817-21.432)</td>
<td>0.004</td>
</tr>
<tr>
<td>PSA Density &gt; 0.3</td>
<td>3.102 (1.115-9.773)</td>
<td>0.031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PI-RADS 5 Lesion</td>
<td>2.8 (1.022-7.669)</td>
<td>0.045</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TZ PI-RADS 4 or 5 Lesion</td>
<td>4.133 (1.448-11.790)</td>
<td>0.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI ECE</td>
<td>4.813 (1.352-17.127)</td>
<td>0.015</td>
<td>4.675 (1.193-18.314)</td>
<td>0.027</td>
</tr>
</tbody>
</table>

¹ Mann-Whitney U test, ² Fisher’s Exact test, ³ Median (range), ⁴ Number (percentage)

RP: Radical prostatectomy, RALP: Robot-assisted laparoscopic radical prostatectomy, TZ: Transitional zone, ECE: Extracapsular extension.
ABSTRACT 41

B-MODE ULTRASOUND ASSESSMENT OF PENILE CORPORAL HETEROGENEITY CORRELATES TO ULTRAFAST™ DOPPLER QUANTIFICATION OF END DIASTOLIC VELOCITY (EDV) IN MEN WITH ERECTILE DYSFUNCTION (ED): FOUNDATION FOR ALGORITHMIC ASSESSMENT OF PENILE FIBROSIS

Rachel S. Rubin1,2, Ashley G. Winter1,2, Irwin Goldstein1

1 San Diego Sexual Medicine
2 Kaiser Permanente San Diego

Introduction: While corporal fibrosis is a significant pathophysiologic component of ED, current ultrasound-based penile imaging protocols do not directly assess it [1]. Veno-occlusive dysfunction, as quantified by elevated EDV of the penile cavernosal artery is a common surrogate for fibrosis, but cannot localize to site-specific lesions. Furthermore, EDV may be abnormal only in advanced disease states. Signal analysis of heterogeneity on B-mode ultrasound of other venous-sinus based tissue (i.e., liver) has been correlated to clinical fibrosis-based disease states [2]. We developed a B-mode ultrasonographic imaging protocol to assess penile corporal heterogeneity, correlated this to EDV, and created the foundation for corporal fibrosis image processing and categorization.

Methods: Following pharmacologic erection, B-mode ultrasound (Aixplorer 15.4 mHz transducer) was performed. Images were captured in the axial plane at the proximal, mid, and distal shaft with gain of 45%, 55%, 65% and dynamic range 70 kB, followed by gain 30% (dynamic range 30-40 kB) for high contrast image. Subjects were grouped into homogenous (Group 1, n=42) mildly heterogeneous (Group 2, n=64), and moderate-severely heterogeneous (Group 3, n=53) by gross assessment of corporal tissue heterogeneity by the clinician. High-reliability assessment of EDV was performed using combined color and pulsed-wave (UltraFast™) Doppler of the cavernosal artery.

Results: We reviewed 159 consecutive duplex Doppler US studies in men with ED (mean age 38.7 yr, IIEF score 13). Mean right cavernosal artery EDV was 0.41cm/s, 1.0cm/s, and 6.1cm/sec for Groups 1, 2, and 3, respectively. Mean left cavernosal artery EDV was 0.40cm/s, 0.9cm/s, and 5.9cm/s for Groups 1, 2, and 3, respectively. Mean difference in EDV between Groups 2 and 3 was -5.10, 95% CI [-1.05, -9.16] right, -5.04, 95% CI [-1.65, -8.44] left. Mean difference in EDV between Groups 1 and 3 was -5.72, 95% CI [-1.19, -10.25] right, -5.59, 95% CI [-1.79, -9.38] left (see figure).

Conclusion: Increased corporal tissue heterogeneity on high-resolution B-mode ultrasound corresponds to higher EDV, a surrogate for increased fibrosis, and may serve as an early marker of ED that is location/lesion specific. Future studies will quantify fibrosis severity using image processing in a user-independent fashion.

Forest plot shows mean differences between paired groups, as labelled on Y-axis
PERCUTANEOUS RENAL ACCESS USING ROBOTIC 3D ULTRASOUND AND TARGETING

Wesley W. Ludwig, Changhan Jun, Sunghwan Lim, Pan Li, Michael A. Gorin, Justin B. Ziemba, Philip M. Pierorazio, Dan Stoianovici, Mohamad E. Allaf

Robotics Laboratory, Brady Urological Institute and Department of Urology, Johns Hopkins University

Introduction: Percutaneous renal access is a required step in a variety of urological procedures. The procedure has been traditionally performed under X-Ray fluoroscopic guidance. Ultrasound guided access has potential advantages related to visualization of surrounding structures and lack of ionizing radiation. However, ultrasound guided access is performed by a limited number of urologists due to technical difficulty. In this study, we investigated the potential utility of a simple robotic system in assisting the urologist with ultrasound-guided access. We present a small and simple robotic targeting system that performs 3D ultrasound scanning and needle targeting, and the results of targeting experiments in an ex-vivo renal model.

Methods: An ultrasound probe (EUP-B512, Hitachi Inc.) was mounted with a special adapter in a 3 degree of freedom (DoF) ultrasound probe manipulator [1]. A needle-guide was designed to fit the system as a part of the adapter. The system is similar to the robot that we previously reported for CT-ultrasound fusion [2, Pg.26]. An ex-vivo mockup was designed and built. This included two porcine kidneys placed in a container and embedded in gelatin. The gelatin was made of a 300 bloom gelatin powder (FX Warehouse Inc., Florida) in solution with sorbitol, glycerin, and water (3/3/2/25 parts in mass, respectively). Five Ø4.7mm ceramic spheres were placed in distinct calyces of the kidneys as targets. The ultrasound probe used is a standard 2D probe. However, when mounted on the robot, it can be used to acquire 3D images, by robotic scanning and recording image-position pairs. The pairs are subsequently rendered in 3D. Dedicated image-acquisition software, navigation, and robot control software was developed in Visual C++ with open source VTK libraries [3]. The targets were identified on the 3D image. The robot automatically positioned the probe so that the needle-guide was target oriented (Figure 1). An 18 gauge trocar needle (Brachystar, C.R. Bard Inc.) was inserted manually through the guide to the depth of the target, which was observed during real-time ultrasound.

Results: Sequentially, all 5 targets were visualized with real-time ultrasound. The robot then oriented the probe based on the 3D image to achieve alignment of the needle-guide and the target. When the needle was inserted through the guide, ultrasound confirmed displacement of the spherical targets as a result of contact with the needle. Accordingly, targeting errors were lower than the sphere radius (<2.5mm). The median scanning and 3D reconstruction, target selection, robot positioning and needle insertion, and the total time were 80±6s, 51±23s, 32±9s, 158±17s, respectively.

Conclusion: Robotic 3D ultrasound imaging and targeting was feasible, rapid, and accurate in an ex-vivo model. The utility in the clinical setting remains to be determined.

Acknowledgement: The ultrasound equipment used in the study was provided by Hitachi-Aloka Medical Ltd.

Figure 1: a) Experimental setup and b) Virtual environment showing the robot with the needle oriented on one of the targets and the real-time ultrasound image.
ABSTRACTS

ABSTRACT 43

MULTI-INSTITUTIONAL EVALUATION OF PRODUCING AND TESTING A NOVEL 3D-PRINTED LAPAROSCOPIC TRAINER: THE UCiTrainer PROJECT

Shoaib Safiullah¹, Renai Yoon¹, Zhamshid Okhunov¹, Daniel J. Lama¹, Benjamin Dolan², Michael J. Schwartz³, Paras H. Shah³, Hannah Bierwiler³, Aldrin Joseph Gamboa⁴, Roberto Miano⁵, Stefano Germani⁵, Dario Del Fabbro⁵, Alessio Zordani⁵, Salvatore Micali⁶, Kamaljot Kaler¹, Ralph V. Clayman¹, Jaime Landman¹

¹Department of Urology, University of California, Orange, USA,
²Department of Engineering, University of California, Irvine, USA,
³Department of Urology, Smith Institute for Urology, North Shore LIJ, New Hyde Park, USA;
⁴Department of Urology, Asian Hospital & Medical Center, Philippines;
⁵Department of Urology, University of Rome Tor Vergata, Rome, Italy;
⁶Department of Urology, University of Modena and Reggio Emilia, Modena, Italy

Introduction: The advent of new minimally-invasive techniques in urologic surgery has led to the establishment of simulator-based instruction to facilitate surgical training and enhance dissemination of these new approaches. However, the cost and constrained portability of commercially available laparoscopic simulators limits access to this essential training tool. With the introduction of three-dimensional (3D) printing technology, we sought to create, distribute, and evaluate a highly portable, inexpensive 3D-printed laparoscopic trainer for surgical skills development.

Methods: The UCiTrainer (UCiT) laparoscopic simulator was developed via computer aided designs (CAD) (Solidworks Software, Dassault Systems, Concord, MA). The CAD files were imported into 3D-printing software (Makerware Software, Makerbot Industries, New York, NY) and a 3D-printer (Flashforge Creator, Zhejiang Flashforge 3D Technology Co, Jinhua, China) to produce the first UCiT. Once assembled, a tablet computer with rear-facing camera (iPad, Apple Inc., Cupertino, CA) was attached for optics. Four institutions were sent the UCiT’s CAD files, a 3D-printer, and the instructions for UCiT assembly. For a comparison of the UCiT to a standard trainer (Karl Storz Inc., Germany) (Richard Wolf Inc., Illinois, USA), peg boards and suture blocks were provided to perform two tasks (peg transfer and intracorporeal knot tying) with accompanying rubrics. Participants were asked to perform the tasks on each trainer in a randomized order; these tasks were scored and participants were asked to rate their experience with the trainers, noting comfort and performance. Lastly, an evaluation questionnaire was given to the individual who 3D-printed and assembled the UCiT.

Results: All participants were urologists; none had any 3D-printing experience prior to this study. The approximate cost of each trainer was $26.50. Each institution used the Apple iPad for UCiT optics. Among 8 respondents tasked with printing the UCiT, six were able to fully assemble the UCiT; half reported building the UCiT in <15 minutes, and the remainder in <45 minutes. Additionally, all respondents felt that 3D-printing would be a useful tool for disseminating surgical education tools. Of note, the more expensive and larger conventional trainers provided a statistically significant better trainee experience (Table 1); however, when it came to task performance, the trainee performed simple and complex laparoscopic tasks equally well with either the UCiT or the conventional laparoscopic trainer.

Conclusion: The UCiTrainer is an easily produced, assembled and functional alternative to contemporary, more expensive and less portable laparoscopic trainers.

Table 1: Device rating reported as median score and (range).

<table>
<thead>
<tr>
<th>Device</th>
<th>Med. Score (range)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITraier</td>
<td>3 (5-10)</td>
<td>4 (5-10)</td>
</tr>
<tr>
<td>Standard</td>
<td>3 (5-10)</td>
<td>4 (5-10)</td>
</tr>
</tbody>
</table>

Table 2: Task performance by laparoscopic trainer.

<table>
<thead>
<tr>
<th>Task Performance</th>
<th>ITraier</th>
<th>Standard</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peg Transfer</td>
<td>36 (28-38)</td>
<td>36 (28-38)</td>
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<td>Intracorporeal Knot Tying</td>
<td>15 (10-21)</td>
<td>15 (10-21)</td>
<td>0.200</td>
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</tbody>
</table>

Figure 1: Assembled UCiTrainer.
USE OF ELECTRONIC QUESTIONNAIRES TO PROVIDE PATIENT–CENTRIC HEALTHCARE IN OVERACTIVE BLADDER

Cristina Palmer DO¹, Bilal Farhan MD¹, Nobel Nguyen BS¹, Tuyen Hoang¹, Lishi Zhang¹, Danh Nguyen¹, Rebecca Do BS¹, Gamal Ghoniem MD, FACS¹

¹University of California Irvine, Irvine, CA

Introduction: Overactive bladder (OAB) syndrome is defined as urinary urgency, usually accompanied by frequency and nocturia, with or without urgency urinary incontinence, in the absence of urinary tract infection (UTI) or other obvious pathology. Electronic questionnaires have been used in few specialties with hopes of improving treatment outcomes and patient satisfaction. However, they have not been widely utilized in the urological field. In treating OAB the main outcome is to improve patient’s quality of life. The primary objective is to evaluate how well the electronic questionnaires are preferred over paper versions. The secondary objective is to look at preference in relation to age, education, and iPad familiarity. By incorporating the use of electronic questionnaires into patient care, we can better improve patient’s experience and health-related quality of life.

Methods: We performed a prospective evaluation of Laborie’s iList® electronic questionnaire application, to patients presenting to UC Irvine’s Urology clinic with OAB using friendly iPad tablet. 72 patients with OAB completed both the validated OABSS and PPBC questionnaires. One group randomized to the electronic format on an iPad and the other to a paper format. Variables potentially associated with the outcomes of interest included demographic data, questionnaire method preference, patient response rate, and iPad use familiarity. We used a 2 sided Z–test to determine whether the proportion of patients who considered iPad to be the same or better than paper was significantly greater than 50%. A two–sided chi–square test is used to assess whether the intervention effect was significantly different among the demographic subgroups.

Results: From November 2015 to August 2016, 72 patients were enrolled, ages 39–87. 53% were female, 47% were 65 years or younger. Those who considered iPad to be the same or better than paper was 80.6% (95% CI, p<0.0001). The percentage of patients who considered iPad to be the same or better than paper ranged from 74% to 96% regardless of age, gender, and education subgroups, as well as among those with any familiarity with iPad (all p < 0.004). Among those with no iPad familiarity (N=19), 42% preferred the electronic questionnaire (p = 0.4913).

Conclusion: We found that the proportion of patients who consider electronic questionnaires to be equivalent or better to paper versions is higher than those who prefer paper questionnaires, regardless of age, gender, or education level. To our knowledge, this is the first integration of electronic questionnaires in the treatment of OAB.

This work was partially supported by grant UL1 TR001414 from the National Center for Advancing Translational Sciences, NIH.
ABSTRACT 45

CLINICAL PARAMETERS FOR CONSIDERATION OF A PROSTATE BIOPSY AFTER A NON-POSITIVE MRI

Rayan Abboud¹,², Christina Buzzy², Amr Mahran¹,², Rajat Thawani², Michael Glover³, Michael Wang², Lee Ponsky¹,²
¹Urology Institute, University Hospitals Cleveland Medical Center, ²Case Western Reserve University School of Medicine

Introduction: National Comprehensive Cancer Network (NCCN) guidelines for prostate biopsy recommend that patients with elevated PSA or a positive digital rectal exam (DRE) obtain a biopsy. As multi-parametric magnetic resonance imaging (mpMRI) becomes increasingly useful for screening patients at risk for prostate cancer, it is important to discern the limitations and strengths of mpMRI. This study aims to identify parameters for a positive biopsy in patients with a non-positive mpMRI.

Methods: In a retrospective IRB-approved protocol, 145 treatment-naive patients were analyzed with a non-positive mpMRI (PI-RADS ≤ 3) and a transrectal ultrasound (TRUS)-guided biopsy that occurred within one year of mpMRI. Following the standard of care, mpMRI’s performed six weeks after a biopsy were excluded due to distortion from hemorrhaging. Patients were stratified in two groups based on their TRUS biopsy results (positive vs. negative). SPSS was used for the analysis.

Results: On univariate regression analysis, the following four variables were identified as significant (p<0.05): prostate volume, mpMRI’s performed less than 156 days after a biopsy, apical lesions detected on mpMRI and race. Low prostate volume, non-white races, and lesions outside the apex are all positively correlated with positive biopsies. Lesions with PI-RADS 3 scores were nearly significant (p = 0.081). Subsequently, the following clinical parameters were added to the model for multivariate analysis: elevated PSA, presence of palpable nodules, family history of prostate cancer and age. After backwards stepwise elimination, only six variables remained in our biopsy predictor model (Table 1, in bold). Area under the curve analysis returned a value of 0.851, nearly double the NCCN’s current biopsy guidelines with a value of 0.442. Our model has a sensitivity of 93.1%, specificity of 47.9% and negative predictive value of 87.5%, ultimately reducing unnecessary biopsies by ~25%. Furthermore, NCCN guidelines for prostate biopsy were six times more likely to misdiagnose patients with cancer than our predictor model.

Conclusion: This analysis suggests that alternative clinical parameters, aside from PSA and DRE, should be considered after a non-positive MRI impression, in order to assess the need for biopsy. Compared to the current recommendation of waiting six weeks after a biopsy to obtain an MRI, our analysis showed a high proportion of false negatives (93.5%) of MRI’s obtained less than six months post-biopsy. Consistent with existing findings, race and prostate volume are both clinically predictive variables. Our biopsy predictor model is capable of generating probabilities of a positive TRUS biopsy. In future studies, we will test our model’s accuracy on validation data sets from other institutions.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Negative Biopsy</th>
<th>Positive Biopsy</th>
<th>Odds Ratio [95% CI]</th>
<th>p value</th>
<th>Odds Ratio [95% CI]</th>
<th>p value</th>
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</thead>
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<tr>
<td>Prostate Volume</td>
<td>70.6 (15.42)</td>
<td>48.5 (12.89)</td>
<td>0.978 (0.966-0.991)</td>
<td>&lt;0.001</td>
<td>0.976 (0.962-0.991)</td>
<td>&lt;0.001</td>
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<td>Post-Biopsy (days)</td>
<td>2/73 (2.7%)</td>
<td>29/72 (40.3%)</td>
<td>23.9 (5.44-105)</td>
<td>&lt;0.001</td>
<td>39.2 (6.85-224)</td>
<td>&lt;0.001</td>
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<td>Race (White)</td>
<td>61/73 (83.5%)</td>
<td>49/72 (68.1%)</td>
<td>0.019 (0.190-0.926)</td>
<td>0.029</td>
<td>0.022 (0.0780-0.574)</td>
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<td>Apex Lesion (MRI)</td>
<td>24/73 (32.8%)</td>
<td>13/72 (18.1%)</td>
<td>0.450 (0.207-0.975)</td>
<td>0.041</td>
<td>0.338 (0.121-0.939)</td>
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<td>PI-RADS 3</td>
<td>29/73 (59.7%)</td>
<td>59/72 (54.2%)</td>
<td>1.76 (0.927-5.47)</td>
<td>0.081</td>
<td>2.21 (0.925-5.27)</td>
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<td>Palpable Nodule</td>
<td>4/73 (5.5%)</td>
<td>6/72 (8.3%)</td>
<td>1.57 (0.425-5.81)</td>
<td>0.498</td>
<td>3.96 (0.681-17.8)</td>
<td>0.073</td>
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<td>PSA (ng/ml)</td>
<td>26/73 (35.6%)</td>
<td>38/72 (52.8%)</td>
<td>0.618 (0.318-1.20)</td>
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<td>Family History, Pca</td>
<td>54/73 (74.0%)</td>
<td>25/72 (34.7%)</td>
<td>1.51 (0.743-3.08)</td>
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<td>Age (yrs)</td>
<td>66.5 (52-85)</td>
<td>67.5 (49-89)</td>
<td>1.02 (0.970-1.06)</td>
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¹Chi-Squared Test; ²Mann-Whitney U Test; Mean; Pca = Prostate Cancer
REAL-TIME OXALATE FEEDBACK: VALIDATION OF A VISUAL URINARY OXALOMETER

Pedro Espino-Grosso BS\textsuperscript{1}, Arun Wanchoo PhD\textsuperscript{2}, Tina Esfendiary\textsuperscript{2}, Alexandria Voigt\textsuperscript{2}, Cuong Nguyen PhD\textsuperscript{2}, Ammon B. Peck PhD\textsuperscript{2}, Benjamin K. Canales MD, MPH\textsuperscript{1}

\textsuperscript{1}Department of Urology, College of Medicine, University of Florida
\textsuperscript{2}Department of Microbiology, College of Veterinary Medicine, University of Florida

**Introduction:** To reduce stone risk, most recurrent calcium oxalate stone formers are asked to avoid foods high in oxalate. However, this recommendation overlooks the health benefits of many oxalate-containing foods (nuts, vegetables) and can be overwhelming. Current laboratory methods for oxalate detection can be time consuming. After 3D printing an easy to use charcoal filtration cartridge, we sought to validate real-time, visual urinary oxalate results against the standard laboratory methods.

**Methods:** Nine healthy subjects with no kidney stone history were identified and recruited prospectively and with IRB approval. Urine was collected approximately every 3 hours throughout a 24-hour period. Subjects were instructed to eat low oxalate foods throughout the day except for lunch where they supplemented their meal with an oral oxalate load (100 grams of spinach). Urine from each individual time point, approximately every 3 hours, and total 24-hour combined urine for all time points were analyzed using a standard urinary oxalate assay (Trinity Biotech Oxalate Kit) and our novel spot urine Oxalometer. Oxalate excretion was detected by simple visual colorimetric (clear to purple) changes and quantified by spectrophotometry.

**Results:** In our healthy cohort, the majority of total 24-hour oxalate excretion, on average 42% of total recovered oxalate, was detected within 4 hours following the oral oxalate load. Urinary oxalate concentrations within this time period approached or exceeded the normalized hyperoxaluria cutoff (0.37 mM or 33 mg/L) while the total 24-hour oxalate measurements remained nominal. The standard Trinity oxalate kit took, on average, approximately 34 minutes to produce an oxalate result using laboratory equipment. Our Spot urinary Oxalometer detected oxalate concentrations in less than 2 minutes.

**Conclusion:** Our urinary Oxalometer provides real-time, color feedback particularly after ingesting a high oxalate load. Unlike the broad oxalate overview provided by a 24-hour collection, this device can quickly determine a post-prandial oxalate spike. This type of personalized feedback may be useful for an individual attempting to limit his/her oxalate intake. Device limitations currently include: 1) lack of specific oxalate readout using a colorimetric scale; 2) lack of dose-response testing (lower level of oxalate detection is unknown); and 3) validation in a cohort of stone formers with hyperoxaluria. Future directions include smartphone applications to convert colorimetric to digital scale and validation of spot urine oxalate values in stone forming cohorts.
ABSTRACT 47

BOILING HISTOTRIPSY ABLATION OF EKER RAT RENAL CARCINOMA PRODUCES SIGNIFICANT CHANGES IN THE IMMUNE SYSTEM

Wayne Brisbane1, Tatiana D. Khokhlova2, Stella Whang2, Kayla Gravelle2, Yak-Nam Wang3, Venu Pillarisetty4, Joo Ha Hwang2, W. Conrad Liles2, Vera Khokhlova2, Michael Bailey2, George R. Schade1

University of Washington, 1Department of Urology, 2Department of Medicine, 3Department of Surgery, and 4Center of Industrial and Medical Ultrasound

Introduction: Evidence suggests focused ultrasound (FUS) tumor ablation may stimulate an anti-tumor immune response. We have been developing the FUS technique boiling histotripsy (BH) as a non-invasive treatment for renal carcinoma (RCC). Previously, we have shown short-term changes in systemic and local cytokines, as well as tumor infiltration of CD8+ T cells following BH. We aimed to characterize the long-term immune response to BH RCC tumor ablation in the Eker rat model.

Methods: RCC bearing genotyped Eker rats (Tsc2 heterozygotes) and syngeneic wild type (WT) non-tumor bearing rats were randomly assigned to transcutaneous BH or a sham US procedure targeting ~0.5 cc of RCC or non-tumor bearing normal kidney. BH was delivered with a 1.5 MHz US-guided small animal FUS system (VIFU-2000, Alpinion) operated at duty cycle of 1-2%, 10-20 ms pulses, 525-600 W electric power. Following treatment, rats were recovered, underwent serial US surveillance, and survived for 7, 14, or 56 days. Following euthanasia, bilateral kidneys, tumor draining lymph nodes (TDLN), and spleen were collected. Flow cytometry was performed on processed tissues to analyze for changes in circulating and local immune cell populations.

Results: At 14 days post-treatment, significant changes in the immune system were observed following BH vs. sham treatment (see Figure). BH treatment was associated with increases in splenic antigen presenting CD11c+ dendritic cells irrespective of tumor status (RCC: 3.4-fold (p=0.048), kidney: 2.3-fold (p=0.03) vs. sham). Conversely, BH treatment was associated with several RCC specific changes in T-lymphocyte populations. Specifically, BH RCC treatment resulted in significant alterations in cytotoxic CD8+ T-cell populations not observed with treatment of normal kidney. Also, BH RCC treatment vs. sham treatment was associated with significant differences in CD8+CD62L−CD44+ effector memory cell (3.0-fold, p<0.01), central memory CD8+CD62L+CD44− cell (7.0-fold, p <0.01), and CD8+CD62L−CD44+ naïve cell populations (0.4-fold, p=0.01) in TDLNs. Similarly, BH RCC treatment was associated with small changes in CD4+ T-cell populations with a near significant 1.9-fold (p=0.08) increase in central memory CD4+CD62L−CD44+ cells in TDLNs.

Conclusion: These data represent the first quantitative analysis of the immune response to BH and hint at an RCC specific response. Ongoing analysis of tumor infiltrating lymphocytes, cytokines, and longer-term 56-day survival will shed further light on the immune response to BH treatment. Further studies, will evaluate the antigen specificity of this response and if it can improve clinically relevant outcomes.

Funding: Focused Ultrasound Foundation, Urology Care Foundation, and NIH K01EB015745 and R01CA154451.

Figure: BH treatment is associated with significant differences in the immune system with RCC specific differences in T-lymphocytes
CONTACT HOLMIUM-LASER LITHOTRIPSY: EFFECT OF DUSTING AND FRAGMENTATION SETTINGS ON STONE MODELS USING AN AUTOMATED 3-D GANTRY SYSTEM

Ali H. Aldoukhi1, Timothy L. Hall2, William W. Roberts1,2, Khurshid R. Ghani1

1Department of Urology, University of Michigan, Ann Arbor, MI, USA.
2Department of Biomedical Engineering, University of Michigan, Ann Arbor, MI, USA

Introduction: Holmium laser systems are now able to offer fragmentation and dusting (low-pulse energy and high-frequency) settings for lithotripsy. Most in vitro studies in this field have explored fragmentation using rudimentary motion systems. In this study we assessed the effect of different laser settings on fragmentation utilizing an automated 3-D gantry system for moving the laser fiber using two widely available stone models.

Methods: We tested two distinct stone models: BegoStone (15:3 powder to water ratio) and Ultracal 30 (100:38 powder to water ratio). Stones were 30 (l) x 30 (w) x 3 (h) mm in size and 3 stones from each stone model were used for each experiment. For holmium laser lithotripsy we used a 60-Watt system (VersaPulse, PowerSuite, Lumenis, CA) and 200 µm fiber (Flexiva 200, Boston Scientific, MA). Prior to each experiment, the laser fiber was stripped and cleaved using a ruby scribe. The laser fiber was positioned with a fiber chuck that was connected to a customized 3-D positioner (Velmex, NY). For each experiment, the positioner was programed using Matlab (MathWorks, MA) to advance the fiber in the same manner: the positioner moved at a speed of 1 mm/s to make 10 connected lines 20 mm long with 2 mm spaces in between. Laser settings assessed were: 0.2 J X 40 Hz (8 W), 0.4 J X 20 Hz (8 W), 1.0 J X 8 Hz (8 W), 0.4 J X 40 Hz (16 W), 0.8 J X 20 Hz (16 W), and 1.6 J X 10 Hz (16 W). To determine stone fragmentation, the difference in stone weight before and after each experiment was recorded. We used micro-sieves (1 and 0.5 mm) to determine sub-millimeter stone fragmentation (dusting) effect.

Results: A total of 36 experiments were conducted. Stone fragmentation at different laser settings for the two stone models is shown in Figure 1. For BegoStone stones, fragmentation increased when the pulse energy was increased. In contrast, Ultracal stones did not show a similar trend. Regardless of the laser setting, none of the stone models produced fragments >0.5 mm in size.

Conclusion: Currently available stone models are not consistent and do not accurately mimic stone response to laser lithotripsy for dusting settings and fragmentation. Our work suggests the need for the development of new stone models that better replicate clinical findings in the era of high frequency laser lithotripsy.

Source of Funding: Research grant from Boston Scientific; Equipment from Lumenis

Figure 1: Results of stone fragmentation at different laser settings using 2 stone models
HIGH FREQUENCY NON-CONTACT HOLMIUM LASER LITHOTRIPSY: IMPACT OF PULSE ENERGY AND TIME ON FRAGMENTATION

1 Department of Urology, University of Michigan, Ann Arbor, MI, USA.
2 Department of Biomedical Engineering, University of Michigan, Ann Arbor, MI, USA

Introduction: Non-contact high-frequency holmium laser lithotripsy (pop-corn effect) is performed when the laser fiber is rapidly activated away from the stone surface, resulting in a whirlpool like effect that causes stones to fragment. A prior study demonstrated that settings of 1.5 J and 40 Hz resulted in the best stone disintegration for fragment sizes <2 mm. The aim of this study was to assess the optimal time needed to achieve disintegration into <1 mm fragments (dusting effect), and the impact of these settings on fiber degradation and burnback.

Methods: Stone phantoms were prepared using Begostone (15:3 powder to water ratio) and were disc shaped with a size of 5 mm x 2-3 mm each. Three stones (weight 0.3g) were then placed in a glass vial (inner diameter 14 mm / length 60 mm), to simulate a caliceal model. Flow was introduced using an open-ended 4 Fr ureteral catheter, connected to a saline bag placed at 150 mmHg pressure, to mimic flow from the working channel of a ureteroscope. The laser fiber was positioned 2 mm away from the highest stone and held in place using a fiber chuck attached to a 3-D positional gantry system. One laser setting was tested, 1.5 J X 40 Hz, for a duration of 2, 4, and 6 minutes; the experiment was paused at each minute to readjust the fiber. The study was performed utilizing a 60-W laser (VersaPulse PowerSuite, Lumenis, CA) and a 200 µm fiber (Flexiva 200, Boston Scientific, MA). Stone fragments were sieved at the end with a 0.5 mm sieve to determine sub-millimeter fragmentation and reduction in stone mass. Fiber tip length was measured before and after each experiment using a digital caliber (Fisher Scientific, NH) to determine fiber burnback.

Results: A total of 9 experiments were conducted. At 1.5 J X 40 Hz setting, the mean percentage loss in stone mass resulting in a sub-millimeter fragment effect was 41.3% (SD 10.6), 71.5% (SD 9.0), and 86.2% (SD 6.6) at 2, 4, and 6 minutes respectively. Stone fragmentation results were significantly different when non-contact lithotripsy was performed for 4 vs 2 minutes (P < 0.05); however, fragmentation results between 4 and 6 minutes were not statistically significant (P = 0.08) (Figure 1). The mean loss in fiber length (burnback) was 2.1 (SD 0.7), 3.2 (SD 0.8), and 4 (SD 0.9) mm at 2, 4, and 6 minutes respectively.

Conclusion: We found an increase in both stone disintegration and fiber burnback with increasing non-contact lithotripsy time. When using 1.5 J x 40 Hz, at least 4 minutes is needed to achieve >50% stone fragmentation at the sub-millimeter level.

Source of Funding: Research grant from Boston Scientific; Laser from Lumenis.

Figure 1: The effect of time on stone disintegration to <1 mm fragments using 1.5J X 40Hz
CONSTRUCTION AND ASSESSMENT OF AN INNOVATIVE INDIGENOUS ULTRASOUND GUIDED PERC SIMULATOR

Ashish V. Rawandale-Patil\textsuperscript{1}, Lokesh G. Patni\textsuperscript{1}, Gautam Ladumor\textsuperscript{1}

\textsuperscript{1}Institute of Urology, Dhule, Maharashtra, India

\textbf{Introduction:} PCNL has a significant learning curve. Ultrasound guided puncture has its definite indications and ultrasound guided PERC simulators are still not available. We describe and validated our own, portable, active mannequin type of ultrasound guided perc simulator.

\textbf{Methods:} A short anatomical study of the coronal sections traversing through the kidney and literature of anatomy was conducted.

The ultrasound guided perc simulator was then designed, patented and constructed using a designed mix of ultrasound compatible medium, aluminium components, ultrasound compatible organ dummies and a mannequin. The simulator allowed ultrasound guided puncture, saline aspiration for confirmation and wire parking into the kidney/ureter. Evaluation using a 3 step test, GRS score and trainee feedback was analysed using Spearman rank order correlations and paired t test.

\textbf{Results:} A total of 16 urology trainees and 2 experts participated in this single center study. Face and content validity as evaluated by the experts demonstrated a satisfactory replication of the retroperitoneal anatomy. The simulator could differentiate novices from the experts. All the subjects demonstrated statistically significant betterment (Spearman rank order correlations) in their GRS scores (p 0.001), total time (p 0.001), fluoroscopic time (p 0.001) and attempted needle punctures (p 0.001). Measured parameters of most trainees showed a shift, towards the control though they were significantly slower than the controls. This indirectly demonstrated the training capabilities of the simulator. Subjective simulator assessment of the trainees indicated a high degree of satisfaction on effectiveness of the simulator.

\textbf{Conclusion:} Our portable ultrasound guided PCNL simulator is the first of its kind. It is portable, uses the usual initial puncture needle, any access technique. The end of task confirmatory saline aspiration and inspectory confirmation of the puncture facilitates faster learning. It allows evaluation and supervised, repetitive tailored learning in a controlled, low stress environment. It has low initial and maintenance cost. Further studies would be aimed at further assessment of training and proficiency abilities. The concept may open up newer avenues in PCNL simulation.
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TOP 10 ABSTRACTS:

PERCUTANEOUS RENAL ACCESS USING ROBOTIC 3D ULTRASOUND AND TARGETING. Wesley W. Ludwig, Changhan Jun, Sunghwan Lim, Pan Li, Michael A. Gorin, Justin B. Ziembra, Philip M. Pierorazio, Dan Stoianovici, Mohamad E. Allaf. Robotics Laboratory, Brady Urological Institute and Department of Urology, Johns Hopkins University

IN VIVO BIODISTRIBUTION AND TOXICITY OF INTRAVESICALLY ADMINISTERED QUANTUM DOTS FOR OPTICAL IMAGING OF BLADDER CANCER. Ying Pan1, 2, Timothy Chang1, 2, Gautier Marcq1, 2, Changhao Liu3, Bernhard Kiss1, 2, Robert Rouse2, 4, Kathleen E. Mach1, 2, Zhen Cheng3, Joseph C. Liao1, 2. 1Department of Urology, Stanford University School of Medicine, Stanford, CA 94305, USA. 2 Veterans Affairs Palo Alto Health Care System, Palo Alto, CA 94304, USA. 3 Molecular Imaging Program at Stanford (MIPS) and Department of Radiology, Stanford University School of Medicine, Stanford, CA 94305, USA. 4 Department of Pathology, Stanford University School of Medicine, Stanford, CA 94305, USA

THE ANATOMICAL REGION SELECTED FOCAL THERAPY WITH TRANS-RECTAL HIGH-INTENSITY FOCUSED ULTRASOUND FOR LOCALIZED PROSTATE CANCER BASED ON THE SPATIAL LOCATION OF SIGNIFICANT CANCER ON MULTI-PARAMETRIC MRI. Sunao Shoji1, Takahiro Ogawa1, Izumi Hanata1, Mayura Nakano1, Hidenori Zako1, Shinichiro Hiraizawa2, Terumitsu Hasebe3, Takuma Tajiri2, Toyoaki Uchida1, Akira Miyajima4. Department of 1 Urology, 2 Pathology, and 3 Radiology, Tokai University Hachioji Hospital, 4 Department of Urology, Tokai University School of Medicine

DEVELOPMENT OF SOFTWARE TO OVERLAY IMAGING DATA IN REAL TIME ONTO THE INTRAOPERATIVE VIEW DURING ROBOTIC SURGERY. Sunghwan Lim, Changhan Jun, Doru Petrisor, Pan Li, Steven P. Rowe, Mohamad E. Allaf, Dan Stoianovici, Michael A. Gorin. Robotics Laboratory, Department of Urology, Johns Hopkins University School of Medicine

B-MODE ULTRASOUND ASSESSMENT OF PENILE CORPORAL HETEROGENEITY CORRELATES TO ULTRAFAST DOPPLER QUANTIFICATION OF END DIASTOLIC VELOCITY (EDV) IN MEN WITH ERECTILE DYSFUNCTION (ED): FOUNDATION FOR ALGORITHMIC ASSESSMENT OF PENILE FIBROSIS. Rachel S. Rubin1, 2, Ashley G. Winter1, 2, Irwin Goldstein1. 1 San Diego Sexual Medicine, 2 Kaiser Permanente San Diego

AUTOMATED AND DYNAMIC CLASSIFICATION OF BLADDER CANCER USING DEEP LEARNING ON REAL-TIME CONFOCAL LASER ENDOMICROSCOPY IMAGES. Timothy C. Chang1, 2, Darvin Yi3, 4, Daniel Rubin2, 3, Joseph Liao1, 4, 1 Department of Urology, Stanford University, Stanford, CA, 2 Department of Medicine (Biomedical Informatics Research), Stanford University, Stanford, CA, 3 Department of Radiology, Stanford University, Stanford, CA, 4 Veterans Affairs Palo Alto Health Care System, Palo Alto, CA. These authors contributed equally to this work

TRUS-ROBOT GUIDED PROSTATE BIOPSY. Misop Han, Sunghwan Lim, Changhan Jun, Doru Petrisor, Dan Stoianovici. Robotics Laboratory, Urology Department, Johns Hopkins University

FEASIBILITY OF AUTOMATING THE MEASUREMENT OF KIDNEY STONE DIAMETER, VOLUME, AND DENSITY FROM CT. Wesley Ludwig1, Pan Li1, Justin Ziembra1, Rishab Gurnani1, Sunghwan Lim1, Changhan Jun1, Satomi Kawamoto2, George Fung2, Dan Stoianovici3, Brian Matlaga1. 1 Brady Urological Institute, 2 Department of Radiology, Johns Hopkins Hospital

ROBOTIC RADICAL PERINEAL CYSTECTOMY AND EXTENDED PELVIC LYMPHADENECTOMY: INITIAL INVESTIGATION USING A PURPOSE-BUILT SINGLE-PORT ROBOTIC SYSTEM. Matthew J. Maurice, Jeremy Reese, Jihad H. Kaouk. Glickman Urological & Kidney Institute, Cleveland Clinic, Cleveland, Ohio
AWARDS:

BEST REVIEWER AWARDS (5 YEARS):

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